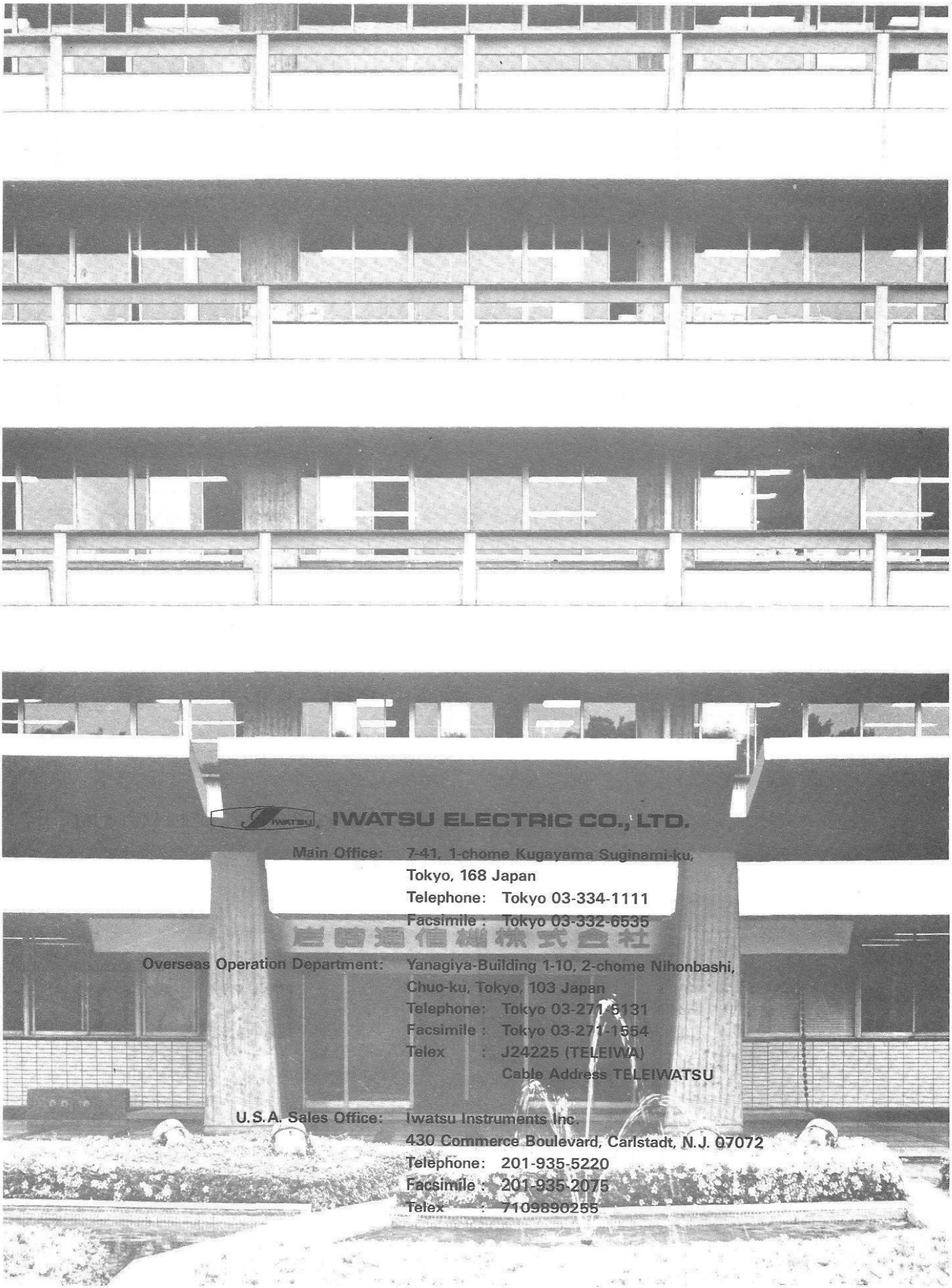
INSTRUCTION MANUAL

Digital Storage Oscilloscopes

DS-6411

A1-916101(L)



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Cautions

Observe the following precautions in using DS-6411.

☐ **Ambient Temperature and Ventilation**

DS-6411 operates normally in an ambient temperature range of 0°C to +40°C. Be sure to use it within this range. Using it outside this range may result in some trouble.

Do not place anything near ventilating holes of the cover, because it will block radiation of heat.

☐ **Supply Voltage Check**

Before pugging a power cord, check a supply voltage. DS-6411 can be used on the supply voltage shown in Table 1, which is set with the supply voltage selector on the rear panel. Check also the fuse in the rear panel in accordance with Table 1. If DS-6411 is used beyond a specified voltage range, it may go out of order.

Before changing over a voltage range or replacing the fuse, be sure to remove a power cord plug from a plug socket.

Table 1 Supply Voltage Ranges and Fuse Spec.

Set Position	Center Voltage	Voltage range	Fuse Spec.	Power Cord
A	100 V	90 V to 110 V	2A, slow-blow	For 100 V
B	115 V	103 V to 128 V		
C	220 V	195 V to 242 V	1A, slow-blow	For 200 V
D	230/240 V	207 V to 250 V		

☐ **Be Sure to Use Specified Fuses.**

DS-6411 uses the fuses shown in Table 1 to protect its circuits against damages caused by an overcurrent. If any of these fuses is burnt out, carefully check for its cause, repair a defect if any, and replace it with a specified one. Never use fuses other than specified ones because it may cause not only a trouble, but also a danger.

☐ **Do Not Impress an Excessive Voltage.**

Each maximum input voltage is as follows.

Do not impress a higher voltage.

CH1•2•3 INPUT	±400 V MAX
EXT CLK INPUT	± 50 V MAX
Z AXIS INPUT	± 50 V MAX

☐ **Use the supplied power cord**

Use the supplied 3 wire power cord.

When operating DS-6411 on the line voltage from a 2-core electrical outlet with the supplied 3-wire power cord and a conversion adaptor, be sure to ground the ground terminal on the rear panel to prevent danger.

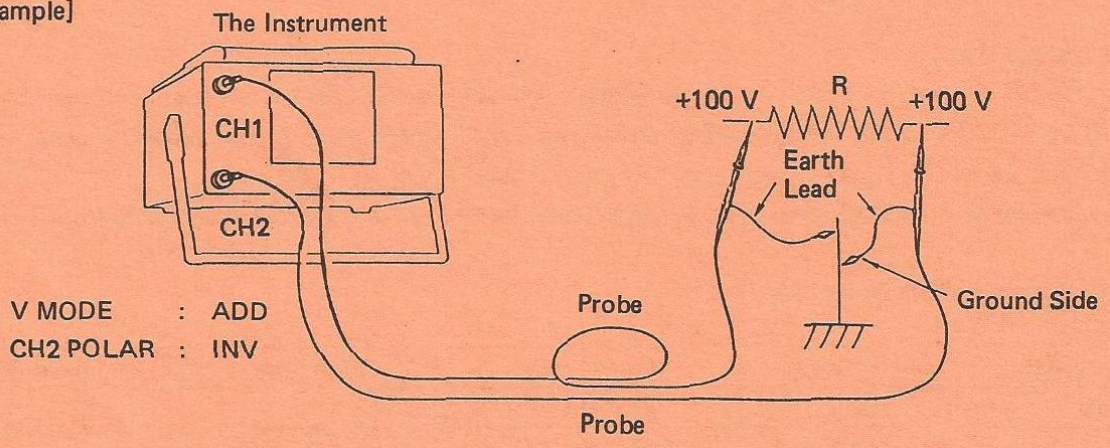
☐ **Observing the Signal Floating from Grounding**

The chassis is always grounded. So, if the ground terminal, etc. of the probe linked with the chassis is connected to a signal source by mistake, it will cause a trouble or damage with the instrument and the measuring circuit.

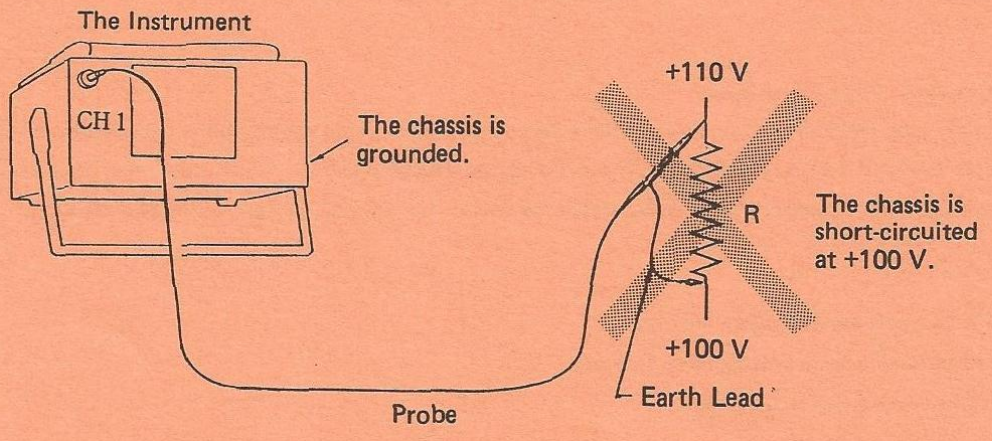
When observing a signal floating over the ground, be sure to adopt the differential input system (V mode and CH2 POLAR set to ADD and INV respectively, and two probes or two coaxial cables used).

Figure 1. Observation Example by Differential Method

[Good Example]



[Bad Example]



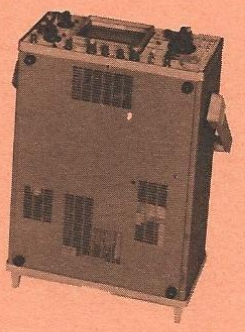
☐ **Do not increase intensity excessively**

Do not increase the intensity of traces or spot more than necessary. Excessive intensity can not only result in eyes fatique, but if left for a long time, it will burn the CRT phosphor surface.

☐ **Using DS-6411 with the CRT screen up**

DS-6411 can be used with the CRT screen up as shown in Figure 2. When used in this position, be careful not to make DS-6411 fall down by pulling hard on the probes connected to the signal input connector.

Figure 2. The CRT Screen Up



☐ **Preheating Time**

To satisfy electrical specifications given in Section 1, a preheating time of 30 minutes or more is required after turning on the power.

☐ **Mounting and Replacing Interface (Option)**

GP-IB (DS-504) interface or RS-232C (DS-505) interface can be mounted on DS-6411. We are ready to mount/replace and adjust the interface. When necessary, contact our salesman in charge or the service station nearest to you.

MEMO

Section 1 Specifications

1-1 GENERAL

DS-6411, which combines a 10 M sample/sec digital storage and a 40 MHz oscilloscope, is a test & measuring instrument. It has many functions for cursor measurement, averaging, peak channel hold, GO/NO GO judgment, and so on.

Features

- Cursor measurements:
  Available either in the real time mode or storage mode. Various measurement can be taken using cursors. Measured results are displayed on the screen.
- Averaging:
  Averaging in the range of 2 to 256 times is allowed in 8 steps.
- Interpolative display:
  Using two types interpolating functions, a waveform is displayed easier to view.
- Peak channel hold:
  Glitch detection and AM modulated wave measurement are provided.
- GO/NO GO judgment:
  An area judged is where two vertical cursors and a domain of the width of reference waveforms overlap.
- Hard Copy:
  Data can be plotted by the pen recorder or the plotter (GP-IB or RS-232C interface unit used).
- CRT readout:
  Measuring conditions and various modes are displayed on the CRT screen.
- Roll mode:
  A waveform can be continuously observed on the CRT screen as a low-speed signal monitor.
- Pretrigger:
  The phenomenon before the trigger point can be observed.
- Sweep delay, waveform enlargement and reduction (X axis: enlargement by SEC/DIV and X10 MAG, Y axis: enlargement and reduction by STORAGE VARIABLE) can be applied to a storage waveform as well as real waveform.

1-2 ELECTRICAL SPECIFICATIONS

1-2-1 CRT

Shape	6-inch rectangular shape
Display area	8 div x 10 div (1 div = 10 mm)
	Non-parallax internal graduations with illumination
Phosphor	B31
Acceleration voltage	Approx. 12 kV

1-2-2 Vertical Deflection System

Mode	STORAGE OFF (REAL)
	CH1, CH2, ADD, DUAL/TRI (ALT, CHOP), X-Y
	CHOP switching frequence: Approx. 130 kHz
	STORAGE ON
	CH1, CH2, DUAL, REF (ON/OFF)
Channels 1 and 2	
Deflection factor	5 mV/div to 10 V/div 1-2-5 sequence of 11 steps
	Accuracy: ±2% (10°C to 35°C)
	5 mV/div to 25 V/div Continuously variable with a fine regulator
	1 mV/div to 2 mV/div (x 5 MAG ON)
	Accuracy: ±4% (10°C to 35°C)
Frequency band width	5 mV/div to 0.2 V/div:
	DC to 40 MHz –3 dB (10°C to 35°C)
	1 mV/div, 2mV/div (x 5 MAG ON)
	DC to 20 MHz –3dB (10°C to 35°C)
	[Note] Lower limit frequency for AC coupling: 4 Hz
Rise time	Approx. 8.8 ns
Square wave characteristics	At 5 mV/div
	Overshoot: 7% (10°C to 35°C)
	Sag (at 1 kHz): 2% (10°C to 35°C)
	Other distortions: 5% (10°C to 35°C)
Signal delay	With delay cable
Input coupling	AC, DC, GND
Input RC	Direct: 1MΩ ± 2% // 32 pF ± 3pF
	With probe: 10MΩ ± 2% // 21 pF ± 3pF
Max. input voltage	Direct: 400 V (DC + AC peak)
	With probe: 600 V (DC + AC peak)
Drift	30 min. after power-on (standard values)
	At 5 mV/div: 0.5 div/hour
	At 1 mV/div: 2.5 div/hour

Common mode rejection ratio	At 5 mV/div 40 : 1 or less (1 kHz sine wave) 15 : 1 or less (5 MHz sine wave)
Inversion	CH2 only
Channel 3	
Deflection factor	0.1 V/div Accuracy: ±3% (10°C to 35°C)
Frequency band width	DC to 40 MHz –3 dB (10°C to 35°C) [Note] Lower limit frequency for AC coupling: 4 Hz
Square wave characteristics	Overshoot: 10% (10°C to 35°C) Sag (at 1 kHz): 3% (10°C to 35°C) Other distortions: 9% (10°C to 35°C)
Input coupling	AC, DC
Input RC	Direct: 1MΩ ± 20%//32 pF ± 8 pF With probe: 10MΩ ± 2%//21 pF ± 3 pF
Max. input voltage	Direct: 400 V (DC + AC peak) With probe: 600 V (DC + AC peak)

1-2-3 Triggering

Source	CH1, CH2, CH3, LINE [Note] External triggering is enabled by setting trigger source to CH3.
Coupling	AC, DC, HF, REJ, TV (A sweep: TV-V, B sweep: TV-H)
Slope	+, –
Maximum trigger level	(10°C to 35°C)

Frequency Range	Level	
	CH1 • CH2	CH3
DC to 5 MHz	0.5 div	1 div
5 MHz to 40 MHz	1.5 div	3 div

[Notes]

- Trigger signals are attenuated in the following frequency ranges depending on coupling
  AC 100 Hz or less
  HF REJ 10 kHz or more
- Auto sweep mode: The lower usable frequency is 50 Hz
- TV-V, TV-H synchronizing signal level: 1 div or more on screen amplitude for a composite video signal composed of 7 parts video signal and 3 parts synchronizing signal.

1-2-4 Horizontal Defelction System

1-2-4-1 STORAGE OFF (REAL)

Mode	A, A INTEN, ALT, B DLY'D
A Sweep	
Sweep mode	AUTO, NORM, SINGLE
Sweep time	0.1 μs/div to 0.5 s/div 1-2-5 sequence of 21 steps
	0.1 μs/div to 1.25 s/div Continuously variable with a fine regulator
	Accuracy I (over center 8 divisions): ±2% (10°C to 35°C)
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	0.2 μs/div ~ 0.5 s/div ±5% (10°C ~ 35°C)
	0.1 μs/div ±7% (10°C ~ 35°C)
Holdoff time	Variable with a regulator
B Sweep	
Delay	Continuous delay (RUNS AFTER DELAY), Triggered delay (TRIG'D)
Sweep time	0.1 μs/div to 50 ms/div 1-2-5 sequence of 19 steps
	Accuracy I (over center 8 divisions): ±2% (10°C to 35°C)
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	0.2 μs/div ~ 50 ms/div ±5% (10°C ~ 35°C)
	0.1 μs/div ±7% (10°C ~ 35°C)
Delay jitter	1/10,000 or less
Sweep magnification	10 times (max. sweep time: 10 ns/div)
	Accuracy I (over center 8 divisions)
	10 ns/div to 50 ms/div: ±5% (10°C to 35°C)
	[Note] 20 ns from a sweep start point and 40 ns from a sweep end point are excluded.
	Accuracy II (over arbitrary 2 divisions within center 8 divisions):
	20 ns/div ~ 50 ms/div ±6% (10°C ~ 35°C)
	10 ns/div ±10% (10°C ~ 35°C)

1-2-4-2 STORAGE ON

Mode	A, A INTEN, B DLY'D
A/B Sweep	
Normal storage	10 μs/div to 0.5 s/div
	[Note] The waveform is automatically magnified at 0.1 μs/div to 5 μs/div.
Roll mode	0.1 s/div to 500 s/div
Sweep magnification	Same as in 1-2-4-1

1-2-5 X-Y Operation

1-2-5-1 STORAGE OFF (REAL)

Input	CH1 for the X axis, CH2 for the Y axis
X axis	
Deflection factor	Same as that of CH1 Accuracy: ±5% (10°C to 35°C)
Frequency band width	DC to 2 MHz –3 dB
Input RC	Same as that of CH1
Max. input voltage	Same as that of CH1
Y axis	Same as that of CH2
X-Y phase difference	3° or less (DC to 50 kHz)

1-2-5-2 STORAGE ON

X-Y axis	CH1 for the X axis/CH2 for the Y axis or REF1 for the X axis/REF2 for the Y axis.

1-2-6 Z-axis

Sensitivity	3 Vp-p
Slope	Positive-going signal decreases the brightness.
Frequency band width	DC to 3 MHz
Input resistance	10kΩ±20%
Max. input voltage	50 V (DC + AC peak)

1-2-7 CRT Readouts and Cursor Measurements

Readouts	The following parameters are displayed: CH1 deflection factor, CH2 deflection factor, CH3 deflection factor, REF 1 deflection factor, REF 2 deflection factor, A and B sweep times, sweep delay time, various modes
Cursor measurements	STORAGE OFF (REAL) ΔV, Δt, VOLTAGE RATIO, PHASE STORAGE ON ΔV, Δt, VOLTAGE RATIO, PHASE, PEAK TO PEAK, GO/NO GO.

1-2-8 Digital Storage

A/D converter	2
Resolution	8 bits
Max. conversion rate	10 M samples/sec
Data length	1 k word or 16 k words
No. of averagings	2, 4, 8, 16, 32, 64, 128 and 256 times
Interpolation function	Linear and sine interpolations
GO/NO GO judgment	Setting with two vertical cursors and a wide waveform
Waveform output	
Pen recorder	Automatically draws scales and waveforms.
Plotter	Recording of scales, waveforms, setting conditions and cursor measured values
Waveform enlargement	
Vertical	X2/3 to X1.5
Horizontal	X1 to X100
Data position	11 steps (0 to 10 div)

1-2-9 Signal Output

Calibrator	
Waveform	Square wave
Repetition frequency	1 kHz
	Accuracy: ±1% (10°C to 35°C)
Duty ratio	40 : 60
Output voltage	0.3 V
	Accuracy: ±1% (10°C to 35°C)
PEN X signal output	
Output voltage	Approx. 0.6 V per division of displayed signal
Output resistance	1 kΩ±20%
PEN Y signal output	
Output voltage	Approx. 0.6 V per division of displayed signal
Output resistance	1 kΩ±20%
PEN UP/DOWN output	
Output voltage	Approx. +5 V (reference voltage: approx. 0 V)
Output resistance	1 kΩ±20% at 0 V
	3.2 kΩ±20% at +5 V
GO/NO GO output	
Output voltage	Approx. +5 V (reference voltage: approx. 0 V)
Output resistance	1 kΩ±20%

1-2-10 Power Supply

Voltage range	100 (90 to 110)/115 (103 to 128)/220 (195 to 242)/230, 240 (207 to 250) V AC Respective voltage ranges can be selected with an AC input voltage selector (A/B/C/D).
Frequency range	50 to 440 Hz
Power consumption	Approx. 80W (at 100 V AC)

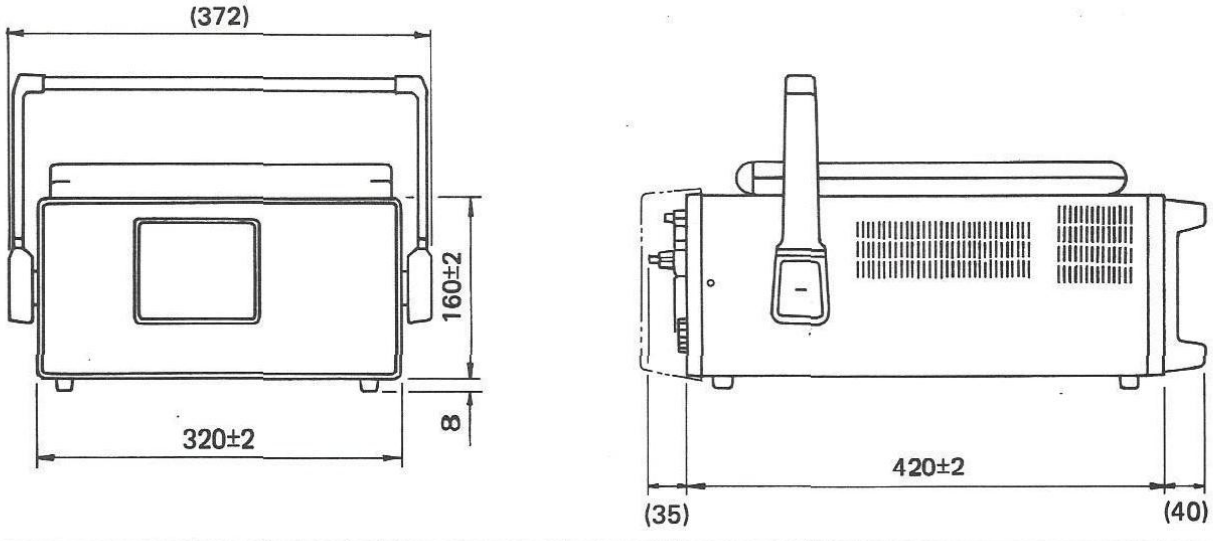
1-3 DIMENSIONS AND WEIGHT

Weight	Approx. 11 kg
Dimensions	(320 ± 2) W x (160 ± 2) H x (420 ± 2) L (mm)

1-4 ENVIRONMENTAL CHARACTERISTICS

Temperature	
Operating	0°C to +40°C
Non-operating	−20°C to +70°C
Humidity	
Operating	Up to 90% relative humidity at 40°C
Non-operating	Up to 80% relative humidity at 70°C
Altitude	
Operating	5,000 m (atmospheric pressure 405 mmHg)
Non-operating	15,000 m (atmospheric pressure 90 mmHg)
Vibration	Vibrated in three orthogonal axes for 15 minutes per axis; 0.63 mm peak-to-peak excursion; 10 to 55 Hz. 1 minute/octave sweep.
Impact	Raise one side 10 cm up (an elevation angle of 30° at maximum) and let it fall on a piece of hard wood. Try this test 3 times for each side.
Drop	After packing the product for transportation, drop it from a height of 90 cm.

Figure 1-3. Dimensions



1-5 ACCESSORIES

Power cord	1
Probe (SS-066R)	2
Fuse	2
Panel cover	1
Dust cover	1
Accessories bag	1
Instruction manual	1

Section 2 Installation

2-1 ENVIRONMENTAL CONDITIONS

Operating conditions are as follows:

Temperature	0°C to 40°C
Humidity	Up to 90% RH at 40°C
Atmosphere	No corrosive gas should be contained.
Altitude	5,000 m (atmospheric pressure 405 mmHg)

CAUTION

To secure proper ventilation, do not place anything near a ventilation hole or a fan.

2-2 AC POWER

Supply voltage:

When the supply voltage is required to be changed after the product is delivered, you can change the voltage range by altering the setting of the AC input voltage selector located on the rear panel in the procedure shown on the right.

Table 2-2 Supply Voltage Ranges

Set Position	Center Voltage	Voltage Range	Fuse
A	100 V	90 V to 110 V	2A SLOW
B	115 V	103 V to 128 V	
C	220 V	195 V to 242 V	1A SLOW
D	230/240 V	207 V to 250 V	

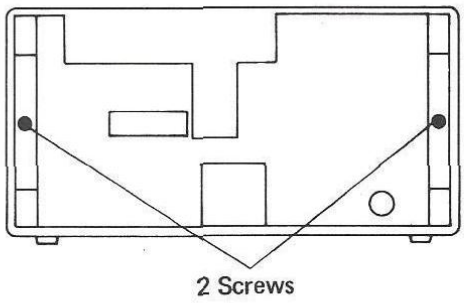
Frequency range: 50 to 440 Hz

Power consumption: Approx. 80W

Setting the AC Input Voltage Selector

Procedure

① Remove the supply cord.



② Remove two screws which fix the rear panel.
③ Remove the rear panel.
④ The plug of AC input voltage selector can be detached by pulling it to this side.
⑤ Insert the plug of AC input voltage selector into a desired voltage indicated position.
⑥ Remount the real panel.
⑦ Fix the rear panel with two screws.

2-3 PROTECTIVE GROUND TERMINAL

The instrument is provided with a three wire power cord.

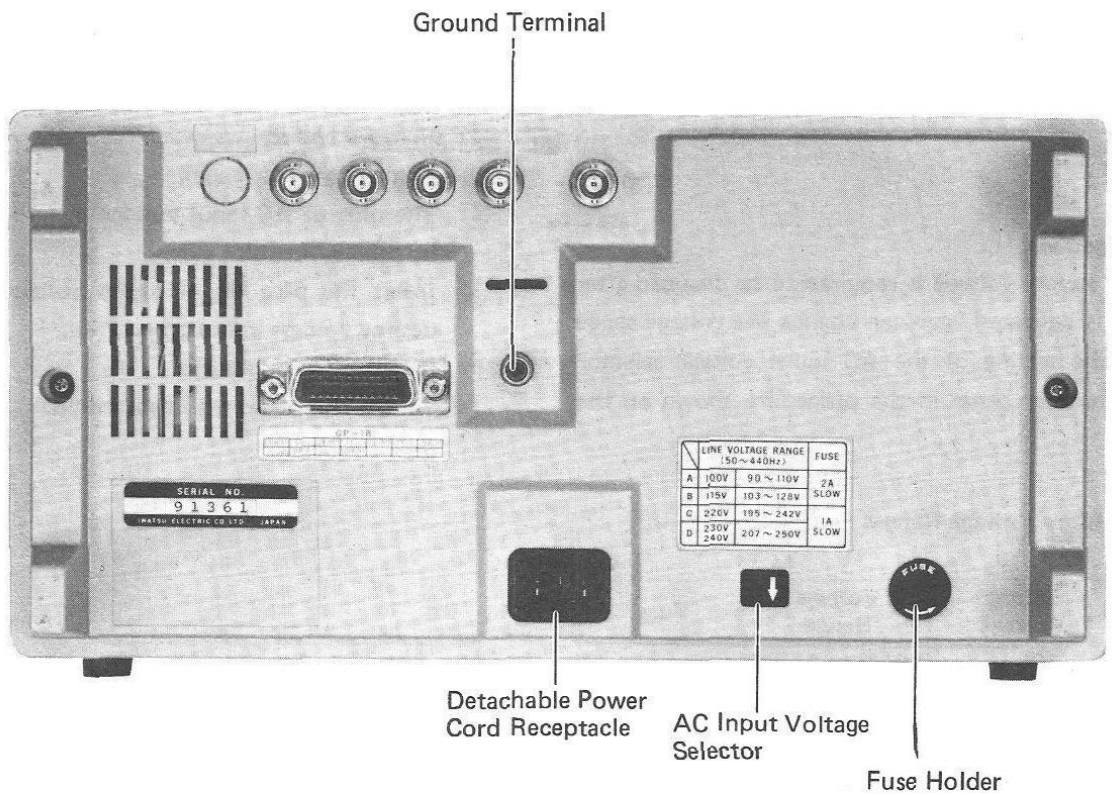
- When supplying the supply voltage from the two-wire power receptacle with a 3-pin/2-pin conversion adapter, strictly observe the following caution:

CAUTION

Be sure to ground the ground terminal of the conversion adapter or that on the rear panel in order to avoid a danger.

- When supplying the supply voltage from the three-wire power receptacle without using the 3-pin/2-pin conversion adapter, it provides a ground for the chassis of the instrument.

Figure 2-3. Rear Panel

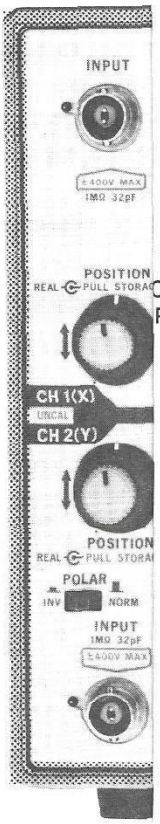


Section 3 Controls,

3-1 FRONT PANEL

Figure 3-1. Front Panel

Verti
Syste



ORAGE Mode and
RSOR Measurements

3-1-1 Power Supply, CRT and Calibration Voltage Output

① POWER Switch

A push-push switch used to turn the instrument power on and off. It must be pushed in to apply power to the instrument and pushed in again to release the switch and remove power from the instrument.

② Power On Indicator

Illuminates when POWER switch is set to the "on" position and power is applied to the instrument.

③ INTENSITY Control (Outer knob)

Adjusts brightness of the CRT trace display. This control does not affect intensity of the CRT readout display.

④ READOUT INTEN Control (PUSH BEAM FIND Switch), (Inner knob)

READOUT: Adjusts the brightness of the CRT readout and cursor displays.

PUSH BEAM FIND: When held in, the display is compressed to within the graticule area and a visible viewing intensity is provided to aid in locating off-screen displays.

⑤ FOCUS Control

Adjusts for optimum display definition.

⑥ TRACE ROTATION Control

Screwdrive control used to align a baseline trace with the horizontal graticule lines.

⑦ SCALE Control

Adjusts graticule illumination.

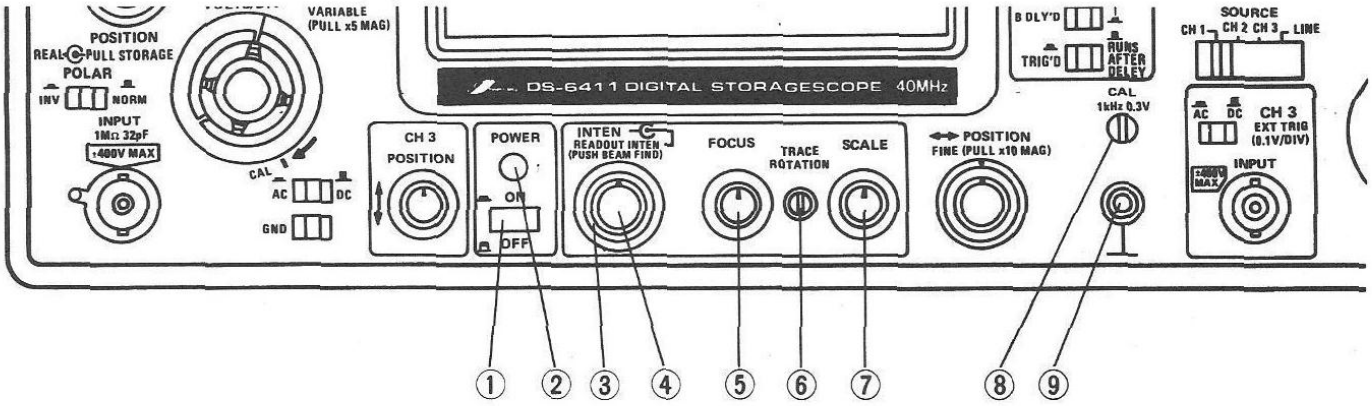
⑧ CAL Output

Provides a 0.3 V squarewave voltage signal with a repetition rate of 1 kHz. It is useful for checking the sweep, the delay and the vertical deffection factor.

⑨ ⊥ (Ground terminal for measurement)

Ground terminal for measurement. Connect it to the ground terminal of the circuit to be measured.

Figure 3-1-1. Power Supply, CRT Control and Calibration Voltage Output



3-1-2 Vertical Deflection System

CH1 and CH2

⑩ INPUT Connectors

Inputs a signal to be measured at CH1 or CH2.

A maximum input voltage is 400 V when directly inputting a signal and is 600 V at a probe tip when the probe is used.

However, it is 400 V MAX. when AC-DC is set to AC.

In the X-Y mode, CH1 INPUT serves as an X-axis input terminal and CH2 INPUT as a Y-axis input terminal.

⑪ VOLTS/DIV Switches (Outer knob)

Selects a vertical deflection factor.

The vertical deflection factor can be selected in 11 steps; 5 mV6div to 10 V/div.

⑫ VARIABLE Controls (PULL x 5 MAG Switches) (Inner knob)

VARIABLE: Provides variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV.

PULL x 5 MAG: Pulling to the knob multiplies a vertical deflection factor 5 times. It allows you to set 1 mV/div and 2 mV/div.

⑬ UNCAL Indicator

Illuminates up when VARIABLE of CH1 or CH2 is set to a position other than CAL (uncalibrated).

⑭ STORAGE VARIABLE Control (OUT)

In position: The vertical deflection factor is fixed in the STORAGE mode.

Out position: The vertical deflection factor can be changed within a range of 2/3 to 1.5 times in the STORAGE mode.

⑮ REAL POSITION Control (Outer knob)

Adjusts a vertical position in the REAL mode.

⑯ PULL STORAGE POSITION Control (Inner knob)

Adjusts a vertical position in the STORAGE mode.

⑰ AC-DC Switches

Selects the method of coupling input signal to the vertical deflection system.

AC: Signals are capacitvely coupled to the vertical deflection system. The DC component of the input signal is blocked.

DC: All frequency components of the input signal are passed to the vertical input amplifier.

⑱ GND Switches

The input of the vertical deflection system is grounded. This allows you to check a ground potential (measurement reference level).

⑲ CH2 POLAR Switch

Displays the signal applied to CH2 INPUT with a polarity inverted.

CH3

⑳ CH3 POSITION Control

Adjusts a CH3 vertical position.

㉑ CH3 INPUT Connector

Inputs a signal to be measured at CH3. A maximum input voltage is the same as that for CH1 and CH2.

㉒ CH3 AC-DC Switch

Selects the method of coupling input signal to the vertical deflection system.

See ⑰ AC-DC.

Modes

㉓ MODE Switch

CH1 : Displays only the signal applied to CH1 INPUT.

CH2 : Displays only the signal applied to CH2 INPUT.

ADD : Displays an algebraic sum or difference of signals applied to CH2 INPUT. CH1 ± CH2 can be selected from CH2 POLAR.

DUAL : Displays signals applied to CH1 and CH2.

TRI : Displays signals applied to CH1, CH2 and CH3.

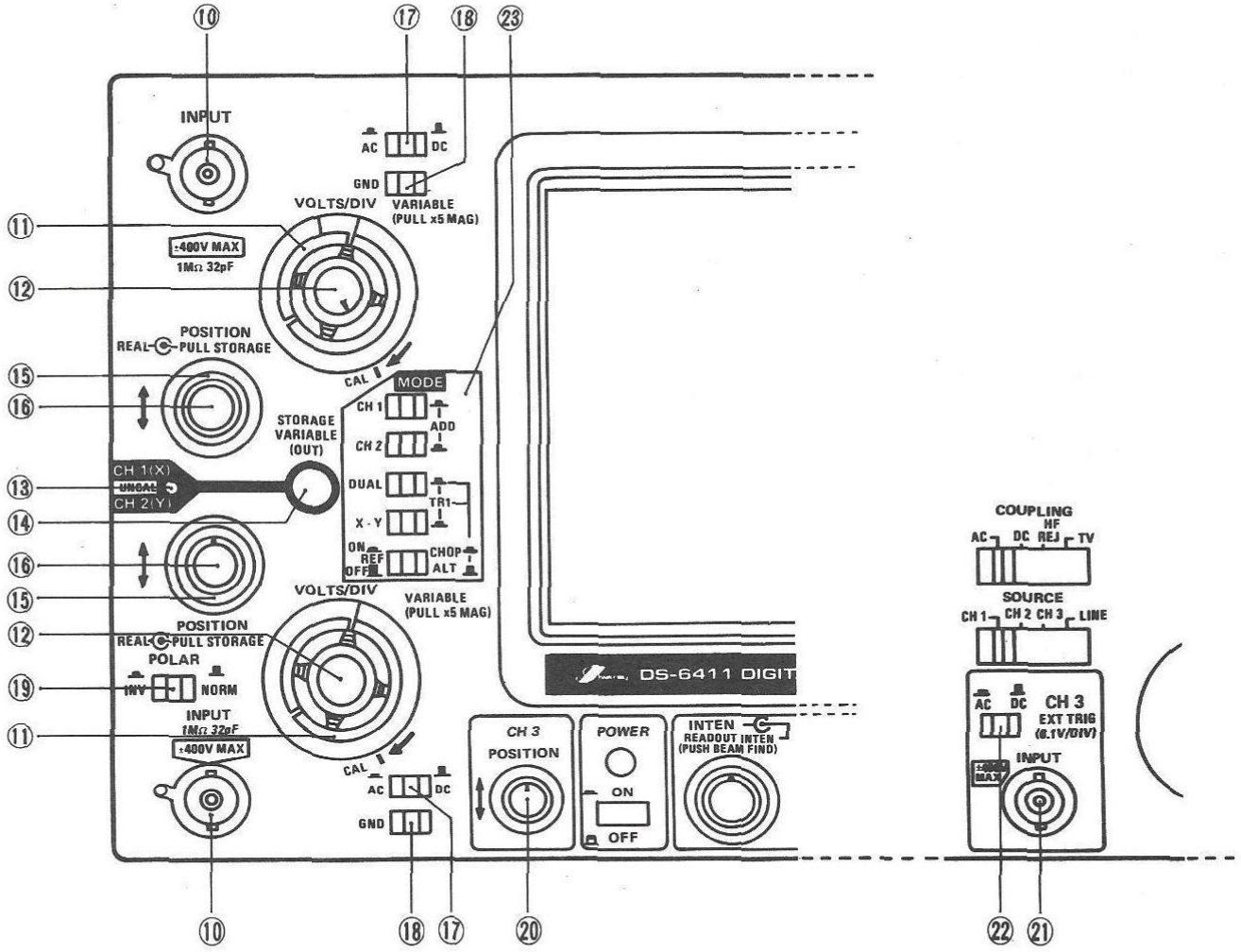
ALT : Alternately sweeps CH1 and CH2 in case of DUAL, and CH1, CH2 and CH3 in case of TRI. Suitable for observation when a sweep time is comparatively quick.

CHOP : Selectively displays CH1 and CH2 in case of DUAL, and CH1, CH2 and CH3 in case of TRI at about 130 kHz. Suitable for observation when a sweep time is comparatively slow.

X-Y : Displays a signal applied to CH1 for the X axis and that applied to CH2 for the Y axis.

REF : Switches a reference memory display on/off in the STORAGE mode.

Figure 3-1-2. Vertical Deflection System



3-1-3 Triggering

㉔ SOURCE Switch

Selects a trigger signal source.

CH1 : The input signal applied to CH1 INPUT results in a trigger signal.

CH2 : The input signal applied to CH2 INPUT results in a trigger signal.

CH3 : The signal applied to CH3 INPUT (EXT TRIG) results in a trigger signal.

LINE : The signal of the power line results in a trigger signal. Used when observing a supply frequency signal or higher harmonics of supply frequency.

㉕ COUPLING Switch

Selects a trigger circuit coupling method.

AC : Selects AC coupling. Capable of triggering regardless of the DC component, because the DC component of a trigger signal is cut.

DC : Selects DC coupling. Capable of triggering from DC.

HF REJ : Selects coupling with a low-pass filter. Frequency components of about 10 kHz or more are attenuated. Suitable for observing a signal containing high-frequency noises.

TV : Selects a coupling method in which the trigger circuit stabilizes a TV signal for triggering.

㉖ CH3 (EXT TRIG) INPUT Connector

Serves as an external trigger input terminal when SOURCE is set to CH3.

㉗ LEVEL Control and SLOPE Switch (PULL—)

LEVEL: Selects the amplitude point on the trigger signal at which the sweep is triggered.

SLOPE: Selects the slope of the signal that triggers the sweep.

+ (plus): Sweep can be triggered from the positive-going portion of a trigger signal.

— (minus): Sweep can be triggered from the negative-going portion of a trigger signal.

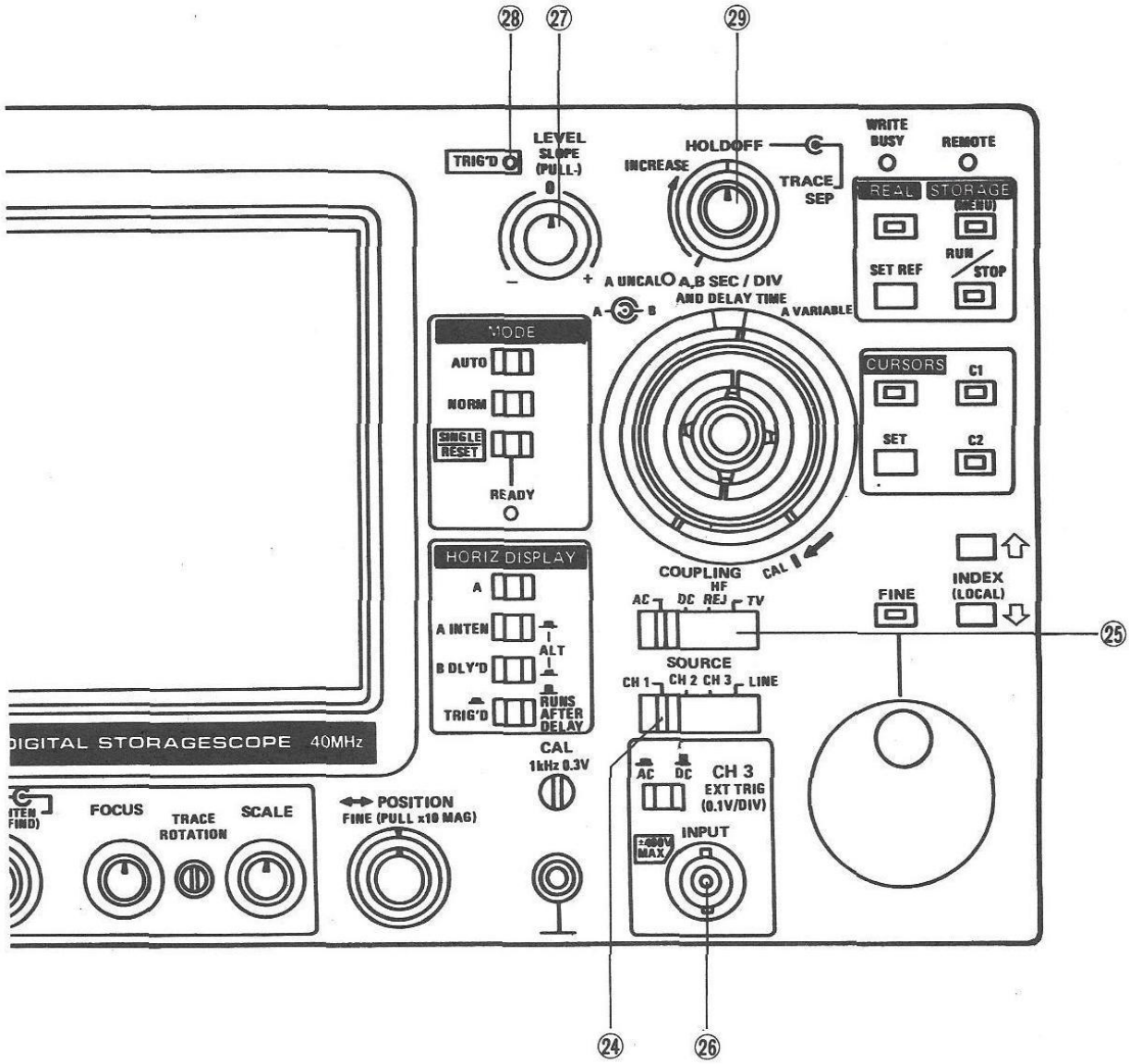
㉘ TRIG'D Indicator

Illuminates to indicate the A Sweep is triggered.

㉙ HOLDOFF Control

Provides continuous control of holdoff time between sweeps. Allows triggering on a periodic signals such as composite waveform.

Figure 3-1-3. Triggering



3-1-4 Horizontal System

㉚ MODE Switch

Determines the mode of trigger operation for the instrument.

AUTO : Permits triggering on waveforms with a repetition rate of about 50 Hz or greater. Sweep free runs and provides a bright baseline when either an adequate trigger signal is absent, or if the repetition rate of the trigger signal is below 50 Hz.

NORM : Sweep is initiated when an adequate trigger signal is applied.

SINGLE : Sweep is initiated one time when an adequate trigger is applied. Sweep cannot be initiated again until the sweep logic is reset by pressing the SINGLE RESET .

㉛ READY Indicator

Illuminates in the SINGLE mode to indicate that the sweep circuitry is armed and ready to initiate the sweep when a trigger signal occurs.

㉜ HORIZ DISPLAY Switch

Select the mode of operation for the horizontal deflection system.

A : Displays only the A Sweep.

A INTEN: Displays the A Sweep at a rate determined by the setting of the A TIME/DIV switch. An intensified portion corresponding to the length and position of the B Sweep will appear on the trace when the B Sweep is properly triggered.

B DLY'D: Displays only the B Sweep.

ALT (A INTEN and B DLY'D): Alternates the display between the A INTEN and B DLY'D sweep.

TRIG'D (Triggered delay): Initiates the B sweep with the first trigger pulses after the time set with A SEC/DIV and DELAY TIME.

RUNS AFTER DELAY (Continuous delay): Allows you to set a delay time as desired.

Although it allows you to start the B sweep from any position of the A sweep, a delay jitter may appear if a magnification is increased too much.

㉝ A SEC/DIV (Outer knob)

Provides a 21-step selection from 0.1 μs up to 0.5 s in a 1-2-5 sequence. A setting range is 500 s/div to 0.1 s/div in the ROLL mode for STORAGE.

㉞ B SEC/DIV (Middle knob)

Provides a 18-step selection from 0.1 μs up to 50 ms in a 1-2-5 sequence.

㉟ A VARIABLE Control (Inner knob)

Provides continuously variable uncalibrated A sweep rates to at least 2.5 times the calibrated setting.

㊱ UNCAL Indicator

Illuminates to indicate that the A SEC/DIV is uncalibrated (VARIABLE control is out of calibrated position).

㊲ POSITION Control (Outer knob)

Adjusts horizontal position coarsely.

㊳ FINE Control (PULL x 10 MAG Switch (Inner knob)

FINE : Adjusts horizontal position finely.

PULL x 10 MAG: Increases the displayed sweep rate by factor of 10. The magnified sweep expands the center division of the unmagnified display. Indicator LED illuminates to indicate that the horizontal display is magnified.

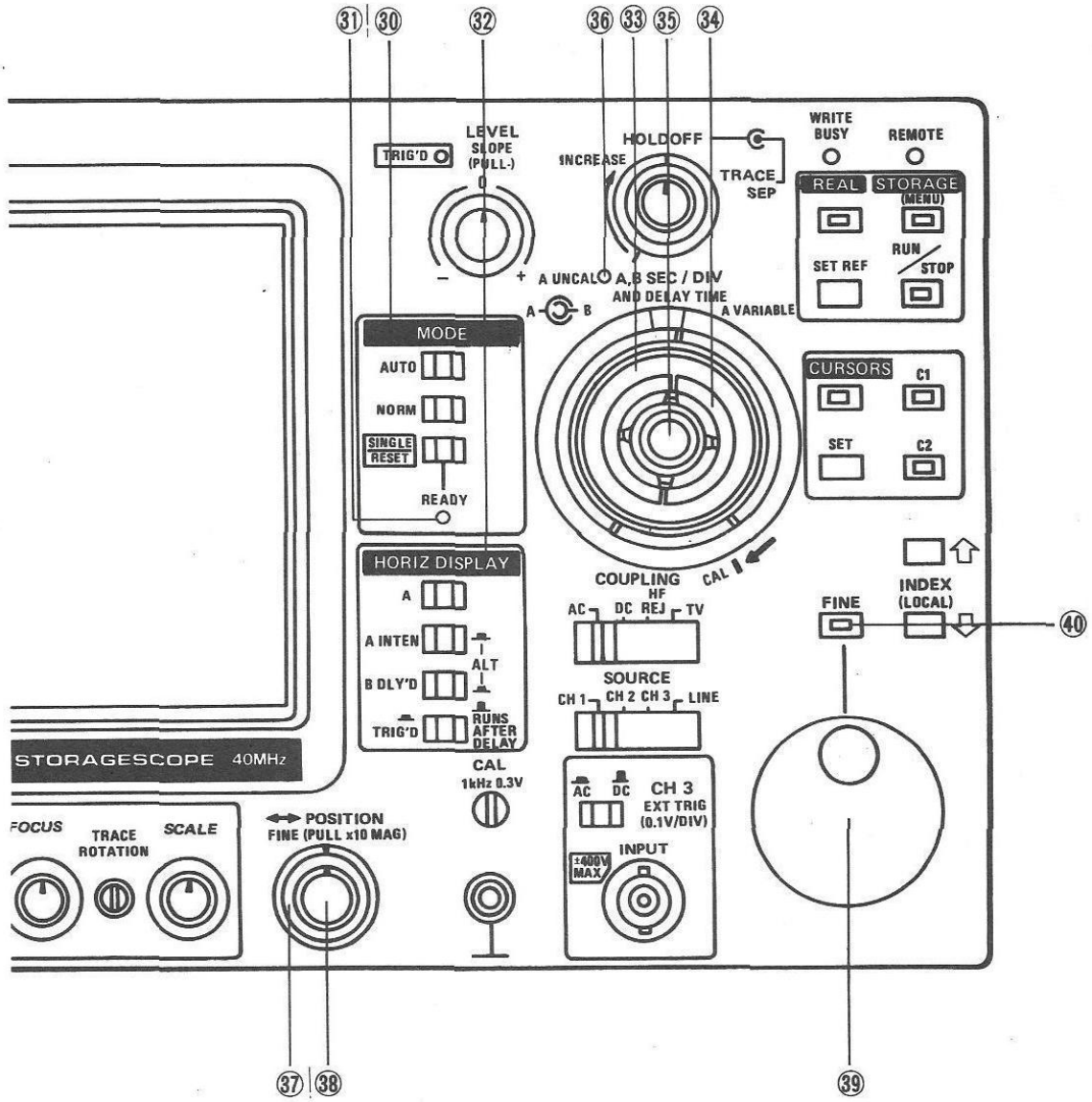
㊴ Rotary encoder

Uses menu selection in the STORAGE mode, cursor measurements and adjustment of a delay time.

㊵ FINE

Fine adjustment when using the rotary encoder.

Figure 3-1-4. Horizontal Deflection System



3-1-5 STORAGE Mode and Cursor Measurement

Storage

㊶ REAL-STORAGE Control

Switches from the REAL mode to STORAGE mode and vice versa.

REAL LED ON : Indicates the REAL mode.

STORAGE LED ON: Indicates the STORAGE mode.

Every time [STORAGE] is pressed, the Measurement screen and the Menu screen are switched over alternately.

㊷ SET REF Switch

Shifts the contents of memories CH1 and CH2 to REF1 and REF2.

㊸ RUN/STOP Switch

When the LED is lit up, writing and reading-out are repeated. When the LED is lit off, a written waveform is continuously displayed as it is, without newly writing.

㊹ INDEX [⇧] [⇩] Switches

INDEX : Selects measuring conditions, etc. on the Menu screen.

LOCAL : Made to Local (the condition enabling panel operation) from REMOTE.

Cursor

㊺ CURSORS Switch

Cursor measurements are allowed when the LED is lit up.

㊻ C1 and C2 Switches

Selects the cursor to be moved in cursor measurements.

[C1] lit up: A broken line (— — —) is moved.

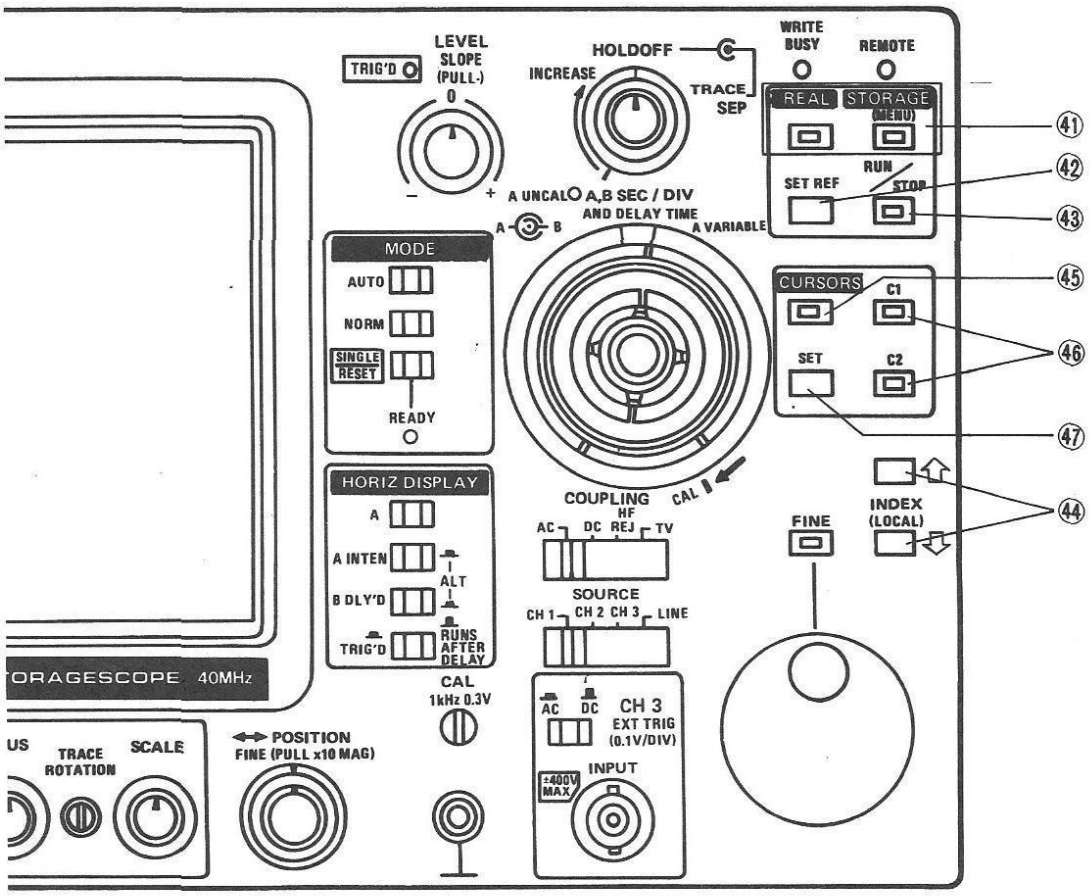
[C2] lit up: A dotted line (· · · · ·) is moved.

[C1] and [C2] lit up: Both lines are moved simultaneously.

㊼ SET Switch

Sets a reference value and selects the cursor to be moved.

Figure 3-1-5. STORAGE Mode and Cursor Measurement



3-2 REAR PANEL

㊽ EXT CLK INPUT Connector

Inputs the external clock signal. Clock signal which is less than 0.6 V at low level, and over 2.7 V at high level. Maximum input voltage is ±50 V MAX.

㊾ *NOGO OUT and *SYNC OUT Connectors

Outputs the following waveforms when setting GO/NO GO.

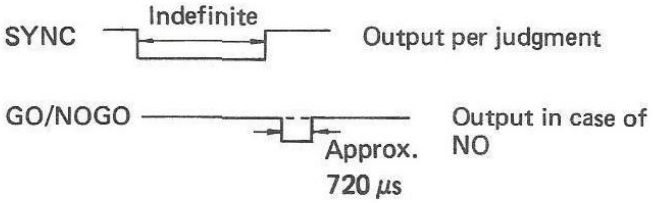
*NOGO OUT: Fetches data upon setting GO/NOGO and outputs a GO/NOGO judgment result per cycle. Negative pulses of about 380 μs are output for NOGO.

*SYNC OUT: Outputs a trigger signal in case of GO/NOGO judgment.

Table 3-2

Output	Output Voltage	Description	Output Resistance
NO GO OUT	Approx. 5 V Approx. 0 V	GO NO GO	3.3kΩ±20% 1kΩ±20%
SYNC OUT	Approx. 5 V Approx. 0 V	Not being judged Being judged	3.3kΩ±20% 1kΩ±20%

Output Waveform Timing Chart



㊾ PEN X OUT, ㊿ PEN Y OUT, (51) PEN UP OUTPUT Connectors

Output the signals to drive the pen recorder.

REC X OUT : Outputs analoque signal for X-axis of pen recorder. Output voltage is approximately 0.2 V per division. Output resistance is 1 kΩ±20%.

PEN UP OUTPUT: Outputs the pen-up signal for pen recorder. Output voltage is approximately 5 V on UP side, and 0 V on DOWN side. Output resistance is 3.2 kΩ±20% on UP side and 1 kΩ±20% on DOWN side.

(52) Z AXIS INPUT Connector

Provides an input connection point to apply external Z-axis modulation signals to the Z-Axis Amplifier.

A maximum input voltage is ±50 V, a frequency range is from DC to 3 MHz, and an input resistance is 10 kΩ ± 20%.

(53) REMOTE

GP-IB or RS-232C interface connector

(54) ⏚ (Protective ground terminal)

It is used for protection. When power receptacle is not made of 3-wire power cord, be sure to make grounding of this terminal for preventing the danger.

(55) Detachable Power Cord Receptacle

Provides the connection point for the ac power source to the instrument.

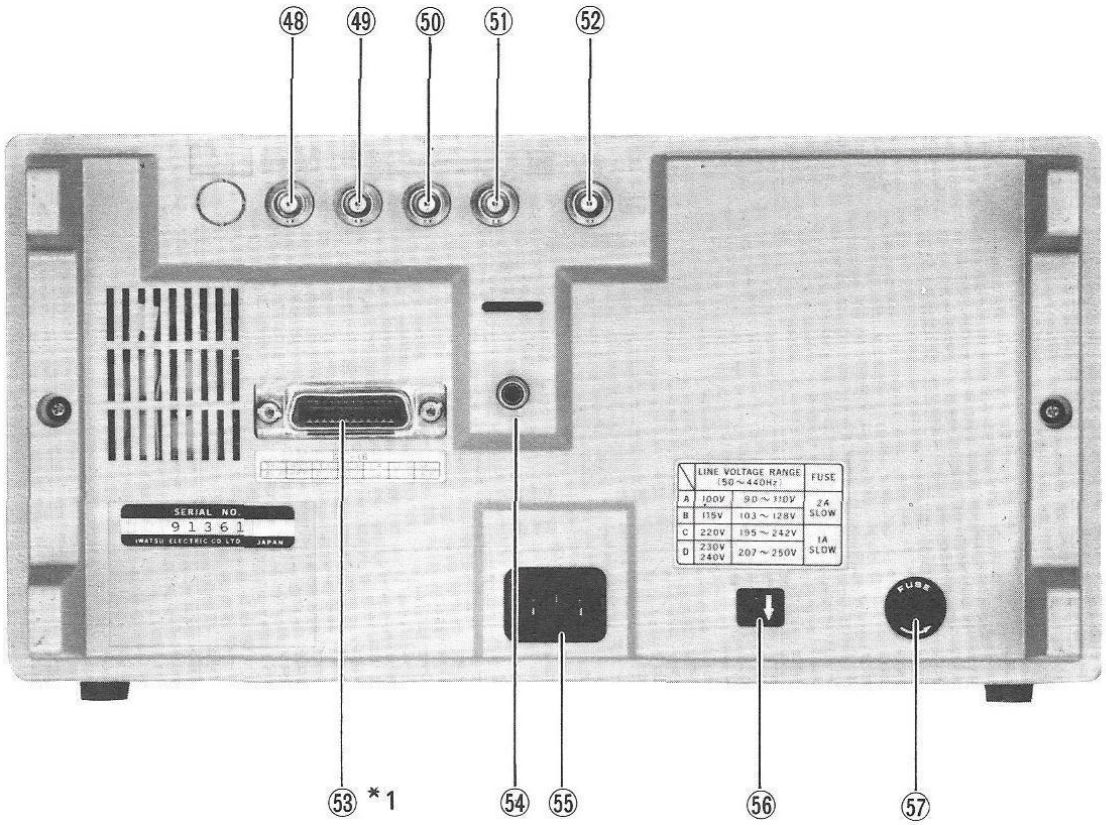
(56) LINE VOLTAGE SELECTOR Switch

To select desired line voltage, position the arror mark of changeover plug to either one of A•B•C•D. Refer to the list labeled "line voltage range". Before changing line voltage, be sure to disconnect the power cord and to dismount the rear panel.

(57) FUSE holder

Contains the ac power-source fuse.

Figure 3-2. Rear Panel



*1 The instrument mounts a GP-IB connector in this Figure.

MEMO

Section 4 Operating Information

Described first below is procedures for outputting a CAL waveform on the screen, using an accessory probe.
Provided next is procedures for checking the functioning of each component unit, using CAL signal mainly.

Operation Guide

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4-1 PREPARATIONS BEFORE TURNING ON THE POWER

Procedure

① Accessories required

Power cord 1

Probe 1

② Checking the position of the AC input voltage selector

Check that the setting position of the selector matches the supply voltage used. (See Fig. 4-1-1.)

If not properly set, adjust it to a correct position, seeing "Section 2, 2-2 AC Supply Voltage".

③ Setting the POWER switch to OFF

Set the POWER switch to OFF. (See Fig. 4-1-2.)

④ Setting the operation switches, etc. on the front panel

Set the operation switches, etc. on the front panel as follows: (See Fig. 4-1-2.)

Vertical axis:

MODE	CH1
CH1 VOLTS/DIV	5 mV
CH1 AC-DC	AC
CH1 GND	OFF (⊥)
CH1 POSITION	Midrange

Triggering:

SOURCE	CH1
COUPLING	AC
LEVEL	Midrange

Horizontal axis:

MODE	AUTO
HORIZ DISPLAY	A
A SEC/DIV	0.5 ms
POSITION	Midrange

CRT control:

INTEN	Midrange
READOUT INTEN	Midrange
FOCUS	Midrange
SCALE	Approx. 90° to the right from the midrange

⑤ Connecting the power cord

Using the accessory power cord, connect the AC power supply and this instrument. (See Fig. 4-1-1.)

Figure 4-1-1. Switches, etc. to Be Operated on Rear Panel

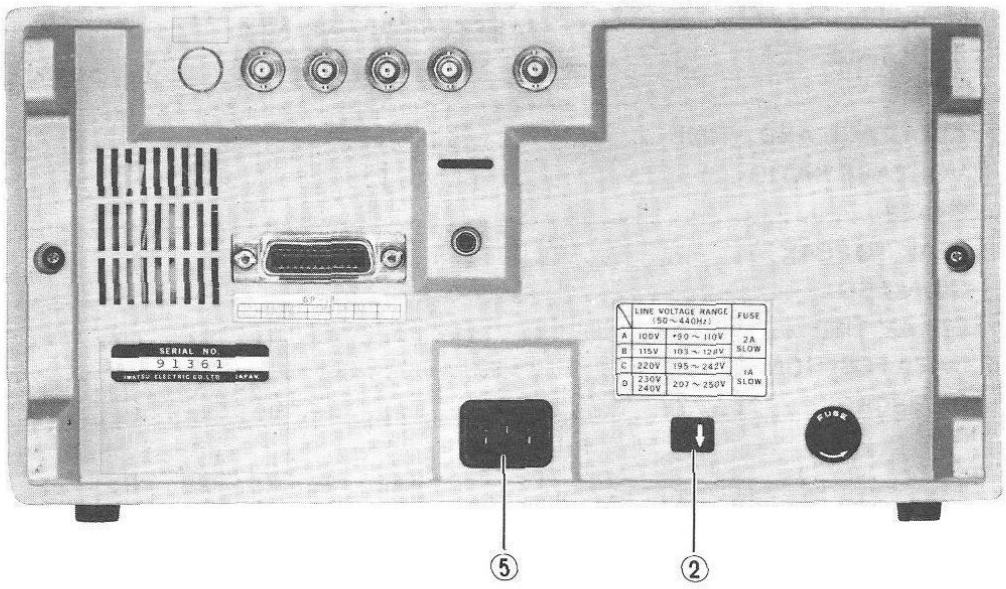
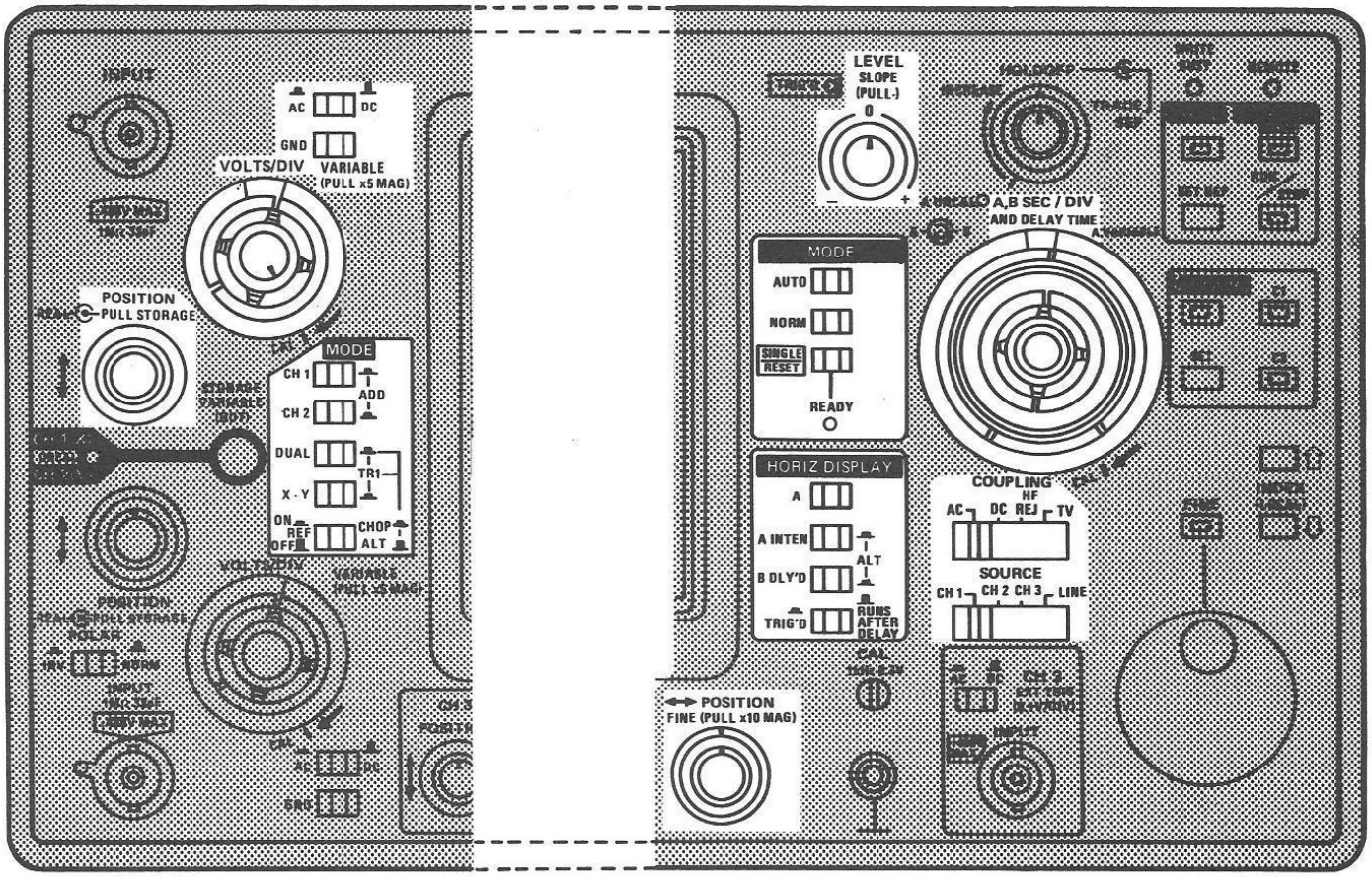
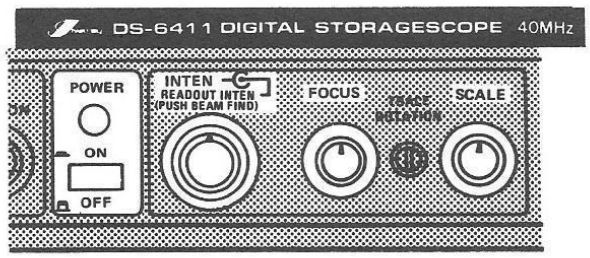


Figure 4-1-2. Switches, etc. to Be Operated on Front Panel

Vertical Deflection System

Triggering and Horizontal Deflection System





Power Supply and CRT Control

4-2 POWER-ON AND CRT CONTROL

Procedure

① Turning on the power

Turn on the POWER switch. The POWER indicator lights up.

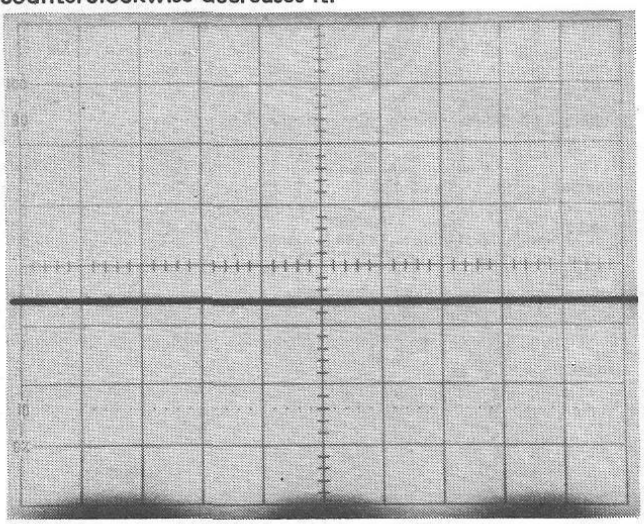
② *Adjusting INTEN (outer knob)*

About 30 seconds after turning on the POWER switch, the trace appears near the center of the screen.

When it does not appear, turn this knob clockwise.

Adjust trace brightness so that it can be easily seen.

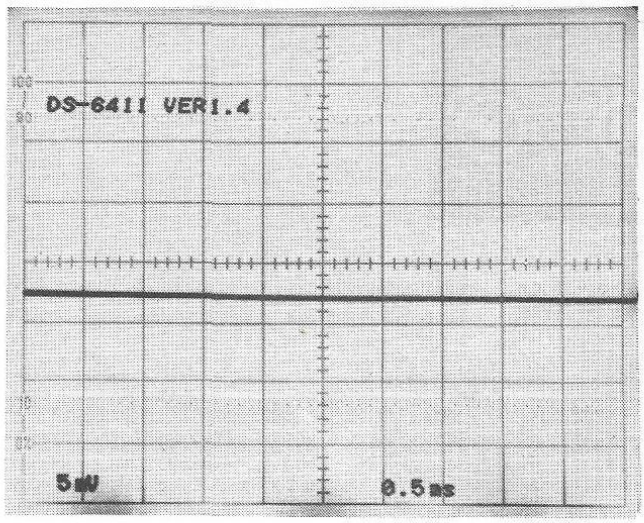
Turning clockwise increases brightness and turning counterclockwise decreases it.



③ Adjusting READOUT INTEN (inner knob)

Turning READOUT INTEN makes a readout display appear. Adjust readout display brightness so that it can be easily seen.

Turning clockwise increases brightness and turning counterclockwise decreases it.

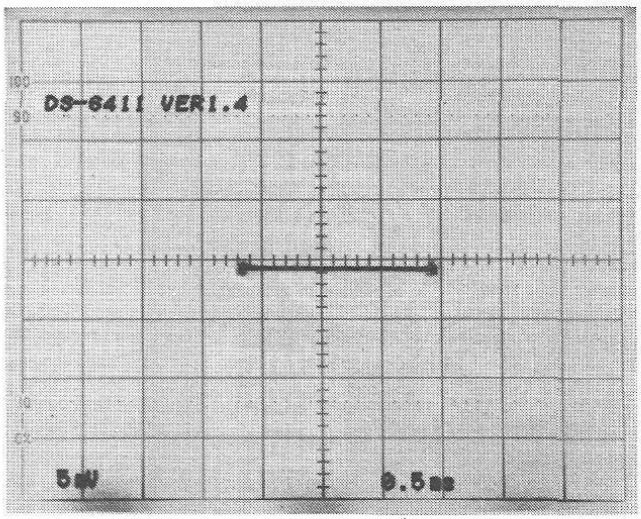


[Note] A version value may be changed.

④ Checking PUSH BEAM FIND

This is used when looking for a trace position.

If you press this knob, the trace outside the screen will appear within the screen. If pressed in the state of ⑧, the following screen will appear.



⑤ Adjusting FOCUS

Adjust the focus to the best condition.

⑥ Adjusting SCALE

Adjust the scale to easy-to-view brightness. Turning clockwise increases brightness and turning counterclockwise decreases it.

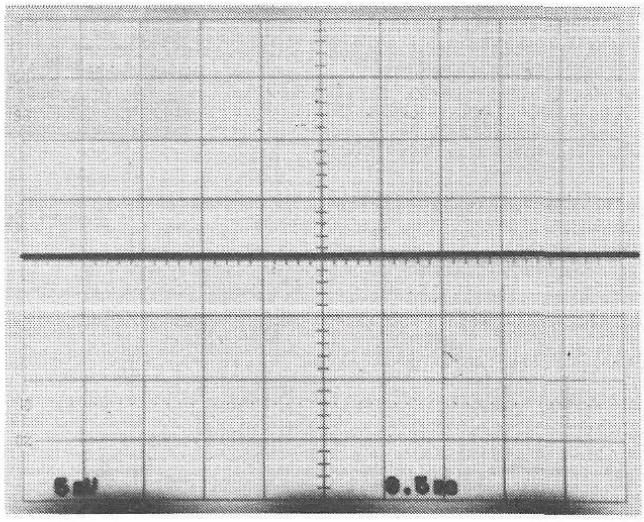
⑦ ↕ REAL POSITION

Adjust a vertical position. Turning clockwise moves the vertical position upward and turning counterclockwise moves it downward.

⑧ Adjusting TRACE POSITION

Using ↕ REAL POSITION, set the trace to the center of the screen and adjust trace parallelism to the horizontal scale of the screen.

Due to an effect of earth magnetism, the parallelism may slightly differ depending on an installation position of this instrument.



4-3 DISPLAYING THE CAL WAVEFORM

① Connecting the Probe

Using an accessory probe, connect CAL output to CH1 INPUT. A CAL waveform with an amplitude of 6 div appears on the screen.

Use of the accessory probe automatically displays the deflection factor of the CH1/CH2 vertical axis at a magnification of 10 times, thus allowing direct reading of displays of the deflection factor.

② Using an accessory screwdriver, correct a probe waveform.

Figure 4-3-1. Connecting the Probe

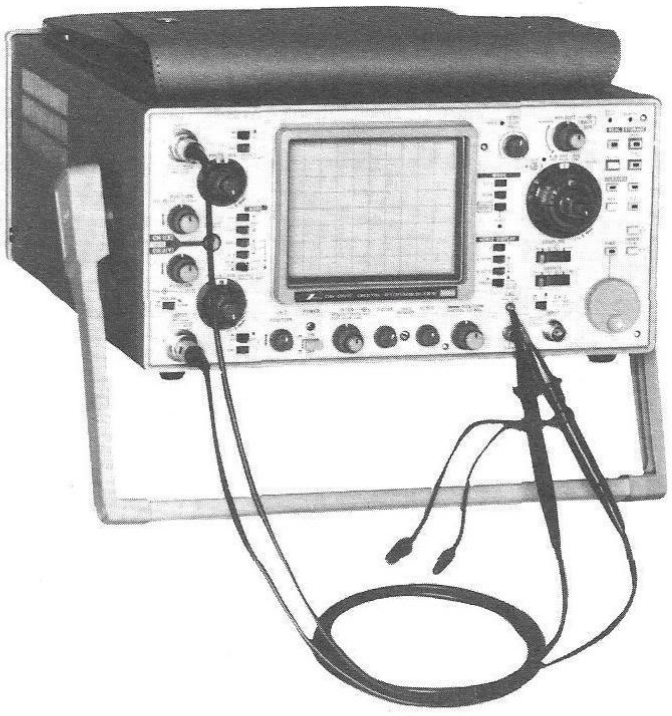
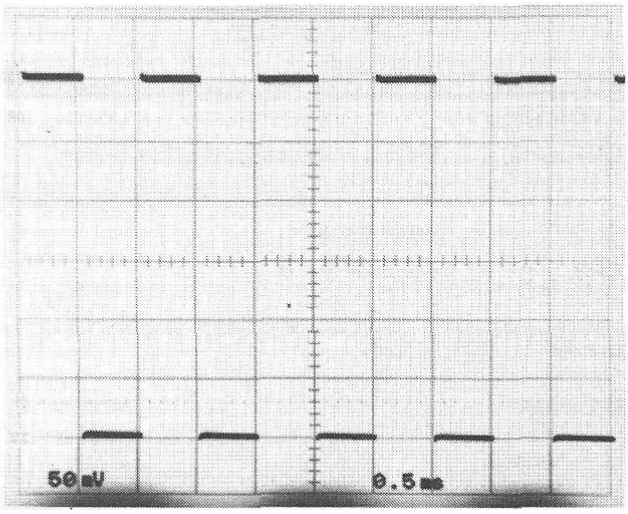


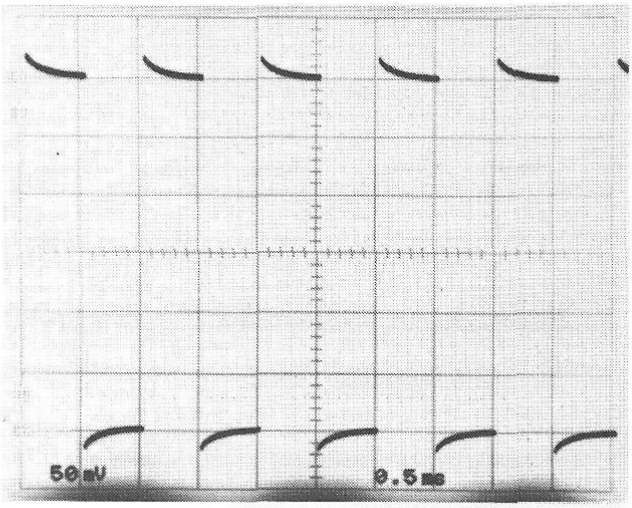
Figure 4-3-2. Correcting the Probe

a) Correct waveform

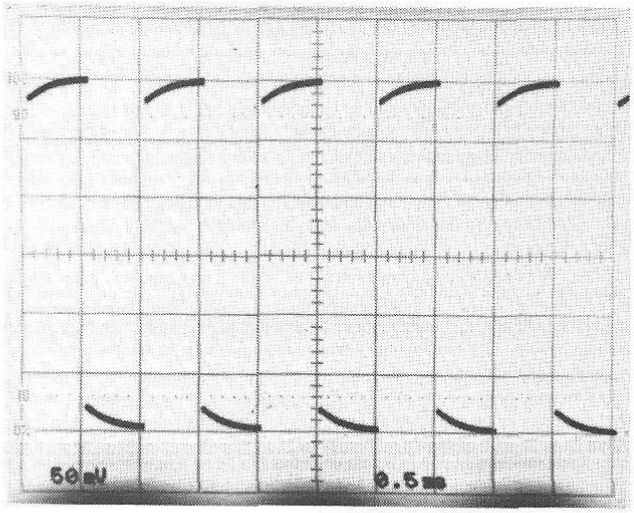


b) Incorrect waveform

Over compensation



Under compensation



4-4 VERTICAL DEFLECTION SYSTEM

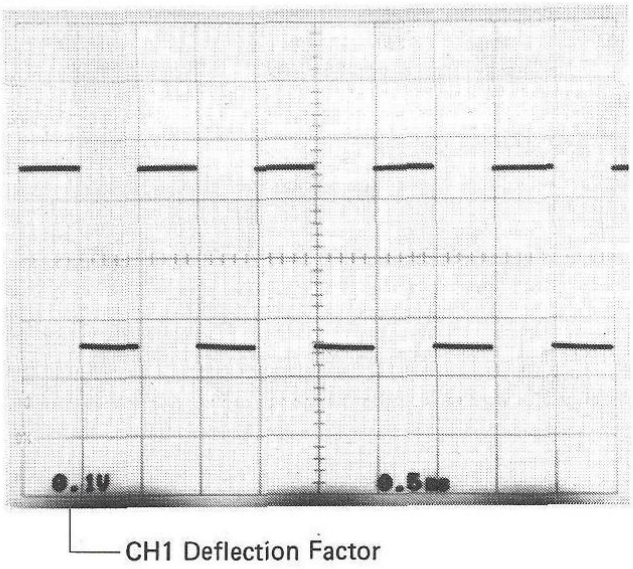
CH1·CH2·CH3

① VOLTS/DIV

CH1, CH2 : Selects a vertical deflection factor. Selects a range in accordance with an input signal.

CH3 : Fixed at 0.1 V.

Figure 4-4-1. VOLTS/DIV

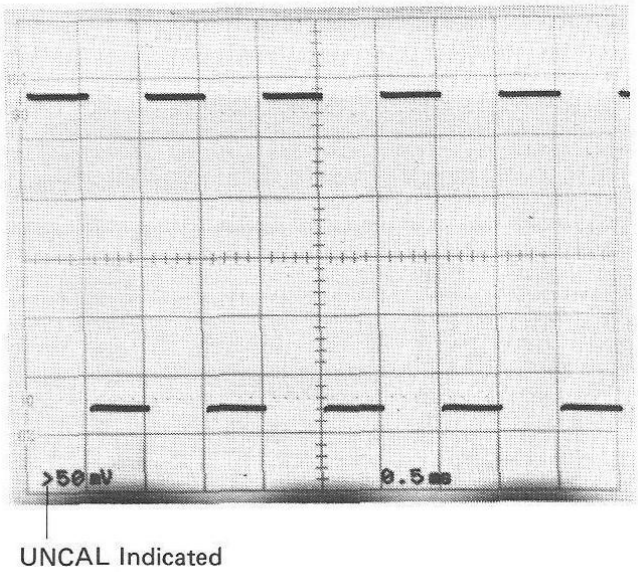


② VARIABLE (PULL x MAG 5)

VARIABLE : VOLTS/DIV fine regulator. Turning fully counterclockwise sets VOLTS/DIV to 1/2.5 or less.

Use of VARIABLE lights up the UNCAL LED on the panel and provides a display with an uncalibrated value mark " > " on the screen.

Figure 4-4-2. VARIABLE of VOLTS/DIV



(PULL x 5 MAG): Pulling this knob to this side enlarges 5 times the waveform on the screen in the vertical direction.

③ ↕ POSITION

Adjusts the vertical position of the trace.

Turning clockwise moves the position upward and turning counterclockwise moves it downward.

④ Input coupling method (AC-DC, GND) selection

DC: All frequency components of the input signal are passed to the vertical input amplifier.

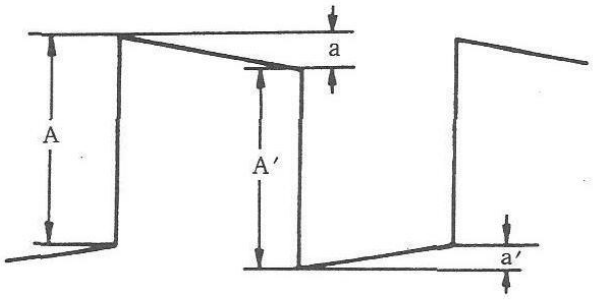
AC: Signals are capacitively coupled to the vertical deflection system. The DC component of the input signal is blocked.

Even if a deflection factor is higher, an AC signal waveform is not moved outside the screen by DC thus enabling observation with high amplitude on the CRT screen.

However, when observing a signal with a low repetition frequency with AC coupling, a sag appears in case of a square wave (refer to Fig. 4-4-3), and if it is a sine wave, it will appear, being attenuated against an actual amplitude. This attenuation is approximately −3 dB at 4 Hz.

GND (Ground): The input of the vertical amplifier is grounded to provide a ground reference.

Figure 4-4-3. Definition of Sag



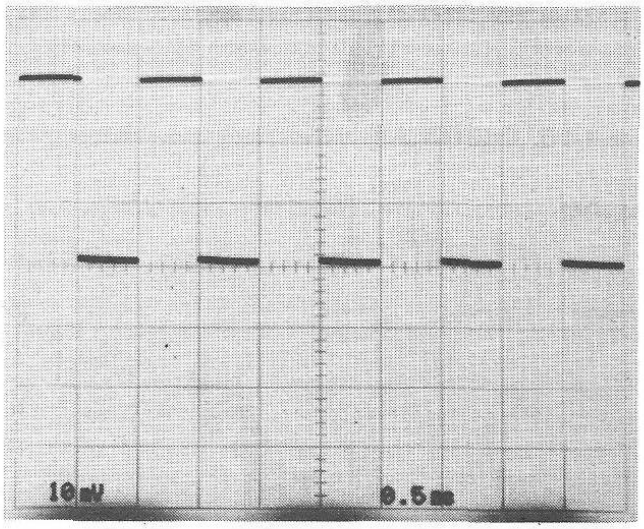
$$\text{Sag} = \frac{a}{A} \left(\text{or } \frac{a'}{A'}\right) \times 100\%$$

taking the bigger value of either $\frac{a}{A}$ or $\frac{a'}{A'}$

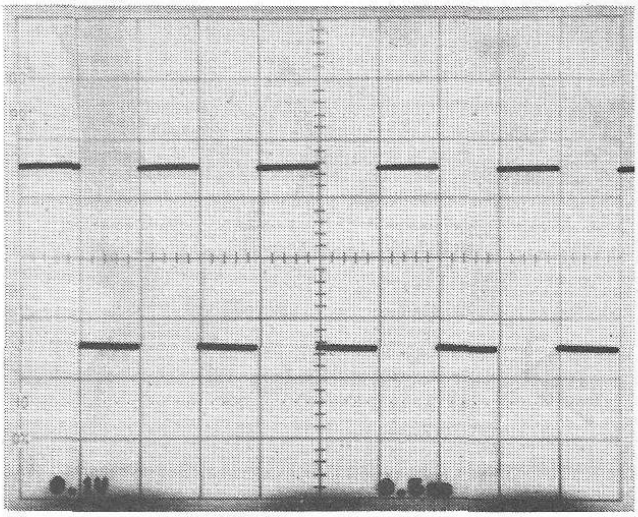
(according to Electronic Machinery Industry Assoc. MEA-27)

Figure 4-4-4. Input Coupling

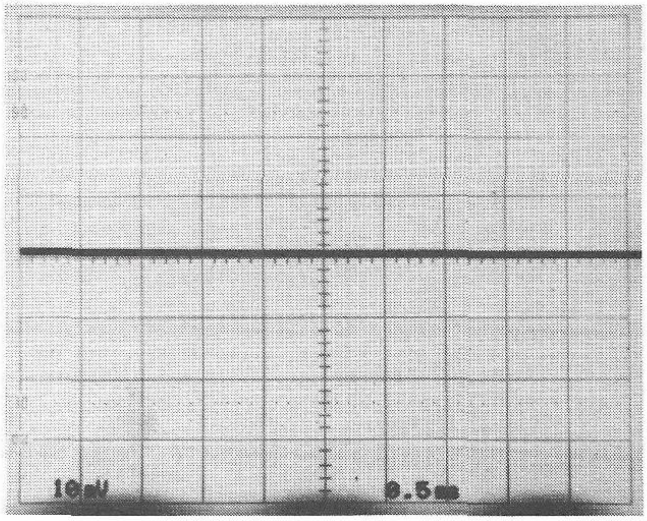
DC Coupling



AC Coupling



GND



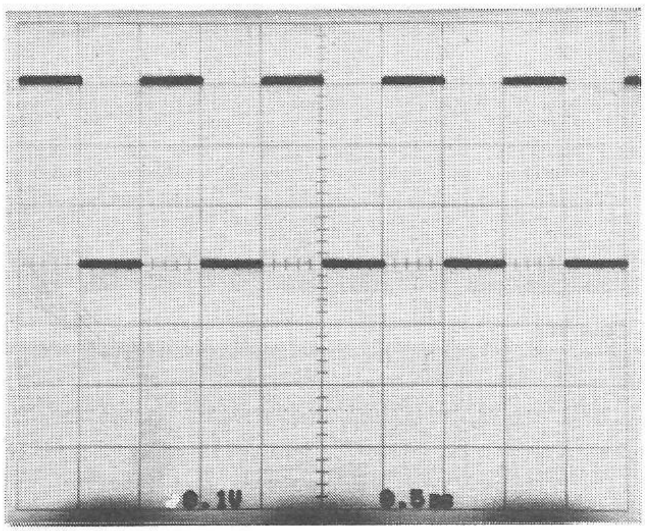
CH2

⑤ POLAR

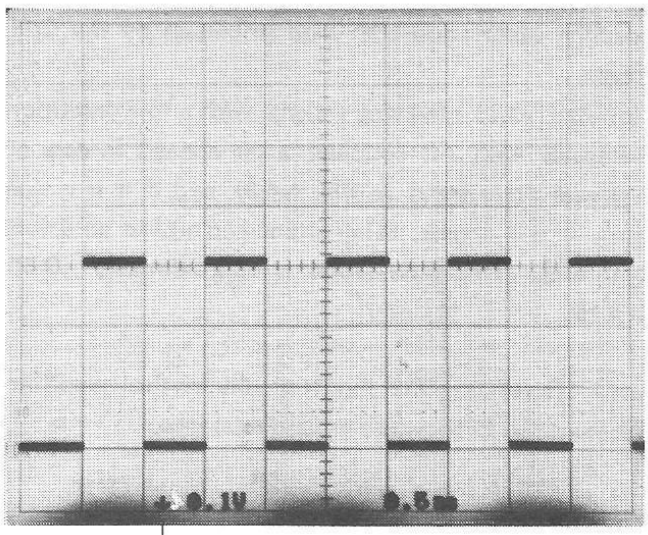
If set to INV, CH2 display is inverted.

Figure 4-4-5. CH2 POLAR

NORM



INV



Polarity: INV Indication

Mode

⑥ MODE

Enables setting of 1-PHENOMENON, 2-PHENOMENON, ADD (sum or difference), X-Y and reference memory display in STORAGE modes.

1-PHENOMENON (CH1 or CH2): Press either CH1 or CH2.

2-PHENOMENON (CH1 and CH2): Press DUAL, and then, select ALT/CHOP.

3-PHENOMENON (CH1, CH2 and CH3): Press DUAL and X-Y simultaneously, and then, select ALT/CHOP.

SUM (CH1 + CH2): Press CH1 and CH2 simultaneously.

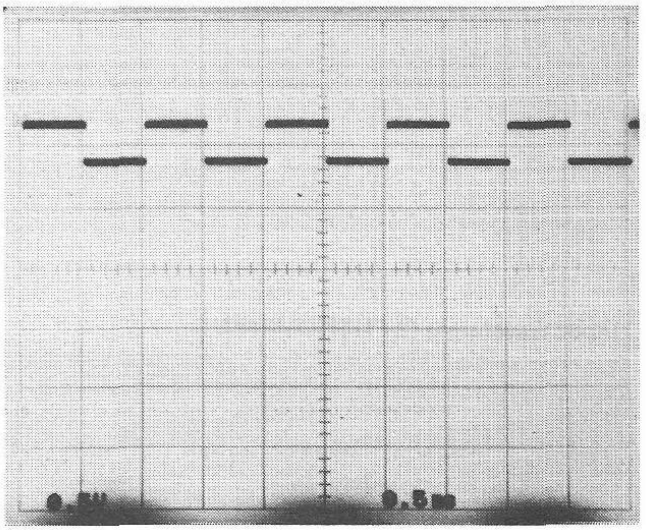
DIFFERENCE (CH1 – CH2): Press CH1 and CH2 simultaneously, and then, set CH2 POLAR to INV.

X-Y (X = CH1, Y = CH2): Press X-Y. Adjust VERT POS with CH2 POSITION.

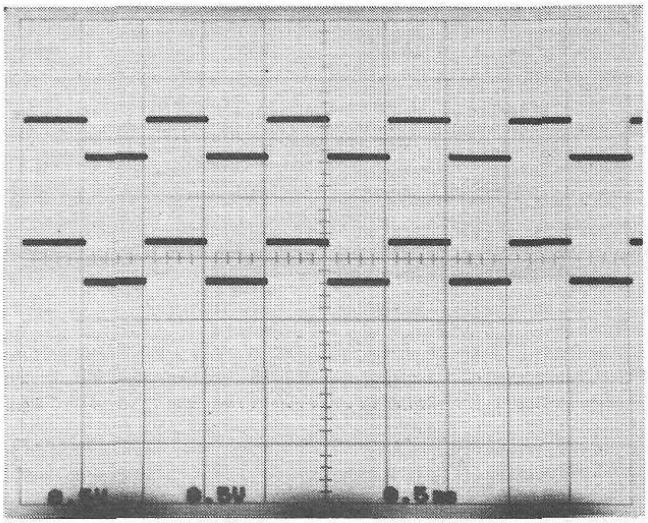
REF: Turns on/off the reference memory display in the STORAGE mode. For details, see "4-7 STORAGE Mode".

Figure 4-4-6. MODE I

1-PHENOMENON (CH1)



2-PHENOMENON (CH1 and CH2)



3-PHENOMENON (CH1, CH2 and CH3)

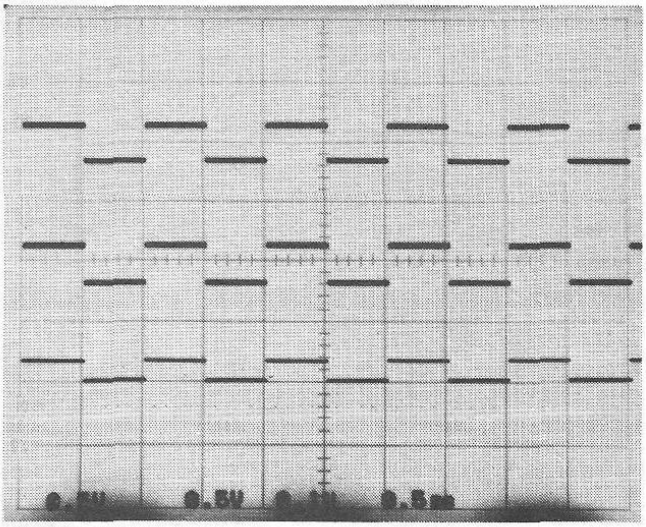


Figure 4-4-7. MODE II (ADD)

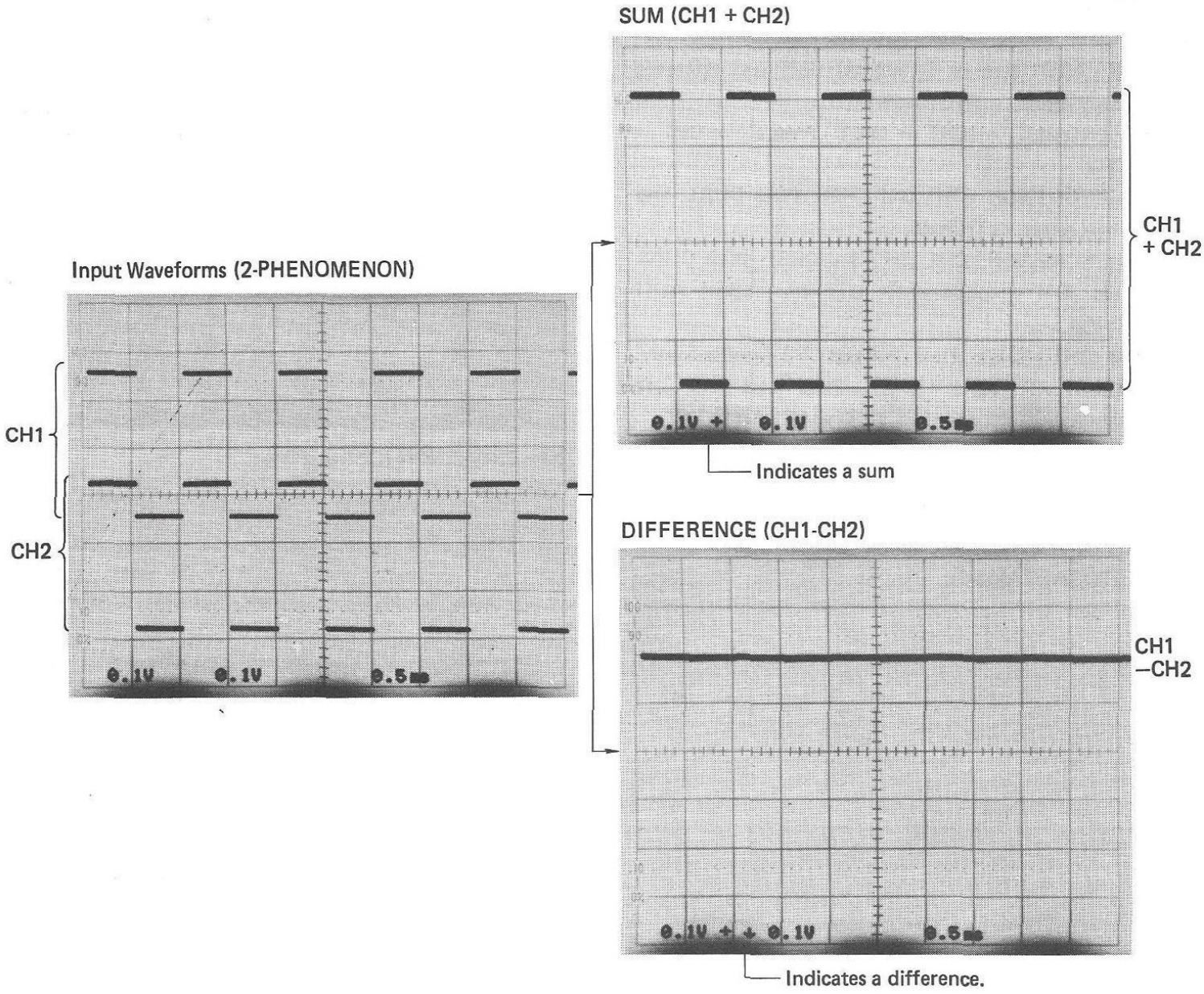


Figure 4-4-8. MODE III (X-Y)

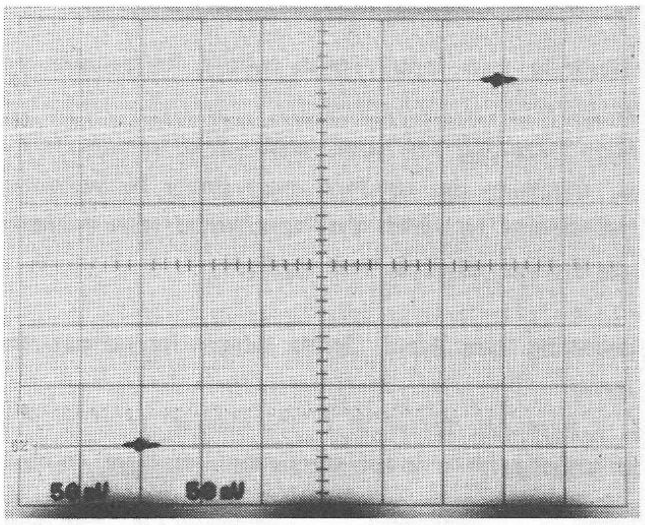


Figure 4-4-9. X-Y Measurement (I)

Phase Difference and Frequency Ratio upon Input of Sine Wave

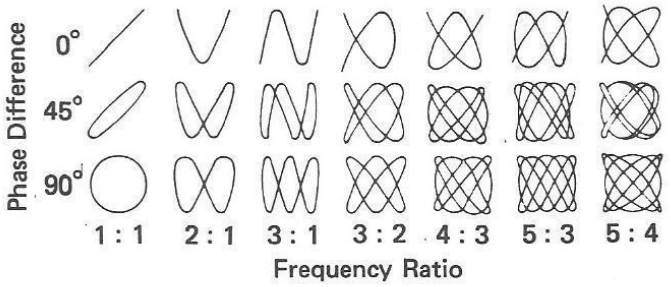
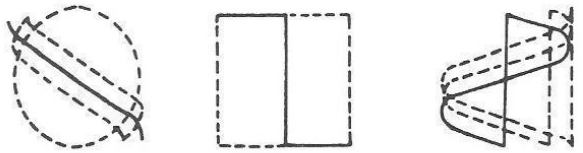


Figure 4-4-10. X-Y Measurement (II)



Sine Wave and Triangular Wave 1 : 1

Sine Wave and Square Wave 1 : 1

Sine Wave and Saw-tooth Wave 1 : 1

4-5 TRIGGERING

Operation to make a measured signal stand still on the screen and draw it is called "triggering". The following describes operation for triggering.

To trigger, the following 5 operational steps are required:

1. SOURCE selection
2. COUPLING selection
3. SLOPE selection
4. LEVEL adjustment
5. HOLDOFF adjustment

① SOURCE selection

In order to trigger, apply to the trigger circuit an input signal itself or a signal, which has constant time relations (multiple, divisur) with the input signal (they are called trigger signals) to actuate the trigger circuit and generate trigger pulses, and drive the sweep circuit with those trigger pulses.

Internal Trigger (CH1, CH2, CH3)

A method, which applies the input signal applied to INPUT to the trigger circuit halfway the vertical deflection system, is called internal trigger.

Setting SOURCE to either CH1, CH2 or CH3 provides internal trigger. In internal trigger, the input signal is internally connected to the internal circuit halfway the vertical deflection system. So, if the input signal is applied to INPUT, even the input signal with a low voltage will be amplified to an appropriate voltage and automatically guided to the trigger circuit.

Therefore, operation is simple and the output impedance of a trigger signal source is not reduced as it is in case of external trigger. Normally, measurement by internal trigger is convenient, taking these advantages into account.

Measuring two input signals whose frequencies are equal:

When measuring two input signals whose frequencies are equal, triggering can be done more stably by switching to the channel to which the input signal with a higher voltage and less noises has been applied.

Measuring two input signals whose frequencies are different:

It is necessary to switch to the channel to which the input signal with a lower frequency has been applied. If switched the other way around, a waveform with the lower frequency cannot be triggered.

External Trigger (EXT TRIG)

A method, which externally applies an input signal itself or a signal having constant time relations with the input signal to the trigger circuit, is called external trigger.

By setting SOURCE to CH3 and inputting to CH3 (EXT TRIG) INPUT a signal which has time relations with a signal input to CH1 or CH2 INPUT, that signal can trigger the signal input to CH1 or CH2 INPUT.

Line Trigger (LINE)

A method, which divides the AC supply voltage and applies it to the trigger circuit, is called line trigger.

Setting SOURCE to LINE provides line trigger.

When measuring a line frequency or its higher harmonics, since line (power supply) trigger divides the AC supply voltage to generate a trigger signal, triggering can be stably done without separately applying the trigger signal.

② **COUPLING selection**

Selects the coupling method of the trigger circuit. This is for stably triggering and displaying on the screen a signal overlapped by AC, DC and higher harmonic noises or a TV signal.

AC: The trigger circuit assumes AC coupling. Triggering is done by only the AC component of the trigger signal. Since the DC component of the trigger signal is cut off, triggering is enabled regardless of the DC component of the trigger signal.

Generally, this AC coupling is convenient. However, triggering becomes difficult when a trigger signal frequency is 100 Hz or less.

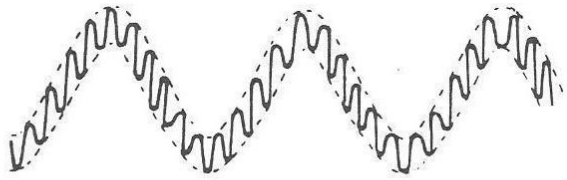
DC: The trigger circuit assumes DC coupling which allows triggering from DC. However, when DC overlaps the trigger signal, no triggering is applied if its DC voltage is outside a LEVEL setting range.

HF REJ: The trigger circuit assumes coupling through a low-pass filter. A high-frequency trigger signal (about 10 kHz or more) or high-frequency noises overlapping the trigger signal are attenuated, thus allowing only the low-frequency component to pass.

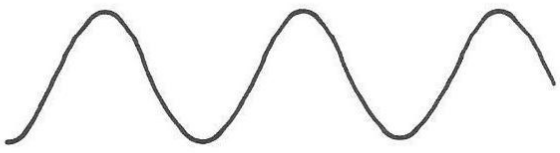
TV: The trigger circuit assumes coupling which stably triggers a TV signal. (See Fig. 4-5-2.)

Figure 4-5-1. HF REJ

a. Trigger Signal Overlapped by High-frequency Noises



b. Trigger Signal with High-frequency Noises Eliminated by HF REJ



• **Observing the TV waveforms of V Trigger Signal**

Procedure

① Set HORIZ DISPLAY to A.

② Set VOLTS/DIV so that the trigger signal will deflect by 1 division or more.

③ Set Horizontal MODE to either AUTO or NORM.

④ For SLOPE, set it to "+" when the trigger signal is of positive polarity, and to "–" when it is of negative polarity.

• **Observing the TV waveforms of H Trigger Signal**

Procedure

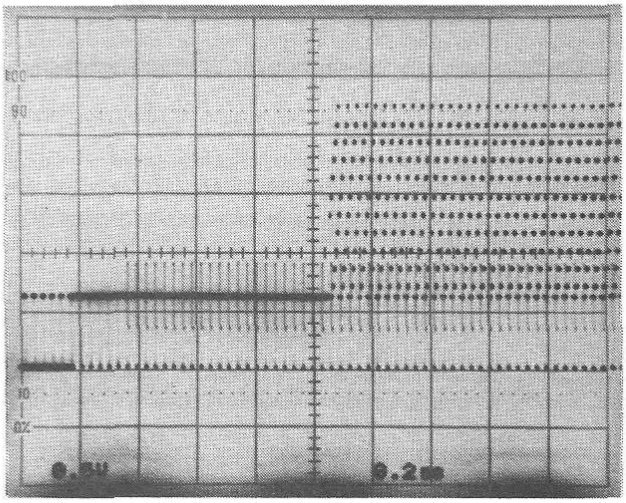
① Set HORIZ DISPLAY to A INTEN.

② Using DELAY TIME (rotary encoder), select the position where the H trigger signal can be observed.

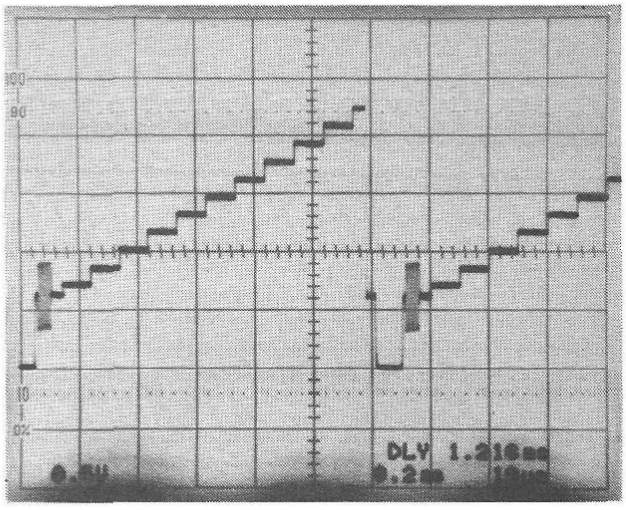
③ Set HORIZ DISPLAY to B DLY'D and select a magnification rate with A SEC/DIV.

Figure 4-5-2. TV Signal Observation

a) V Trigger Signal and Video Signal



b) H Trigger Signal and Video Signal



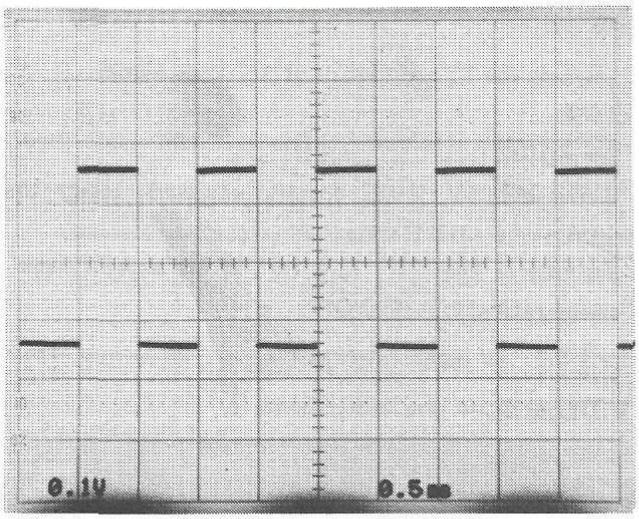
③ SLOPE selection

Select slope (+ or —) of the trigger signal.

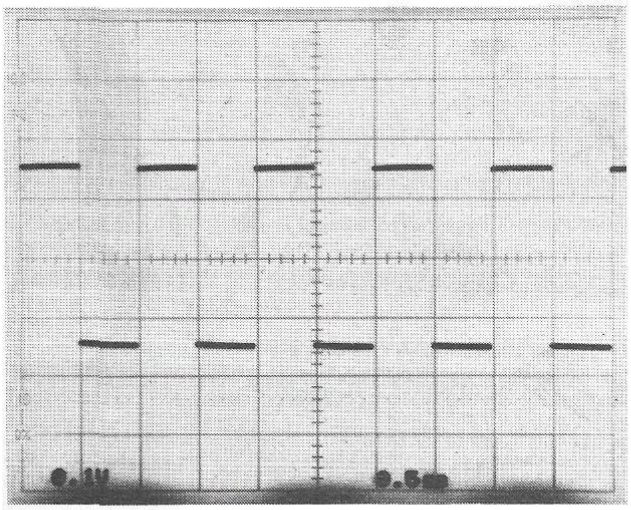
When triggering with the positive slope, press the LEVEL knob, and when triggering with the negative slope, pull the knob to this side.

Figure 4-5-3. Slopes

Positive (+) Slope



Negative (—) Slope

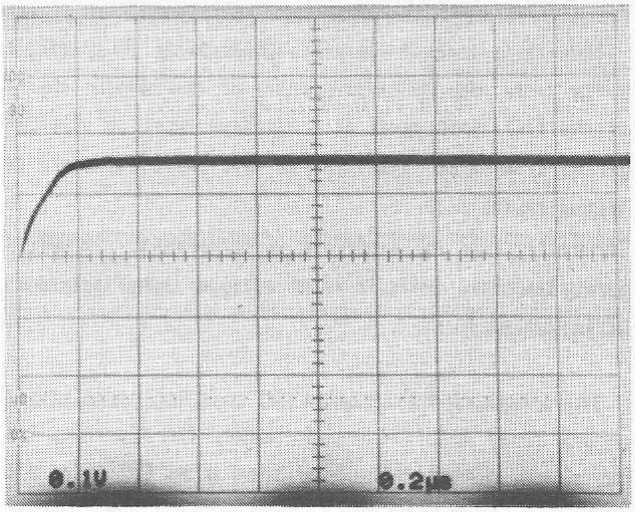


④ LEVEL adjustment

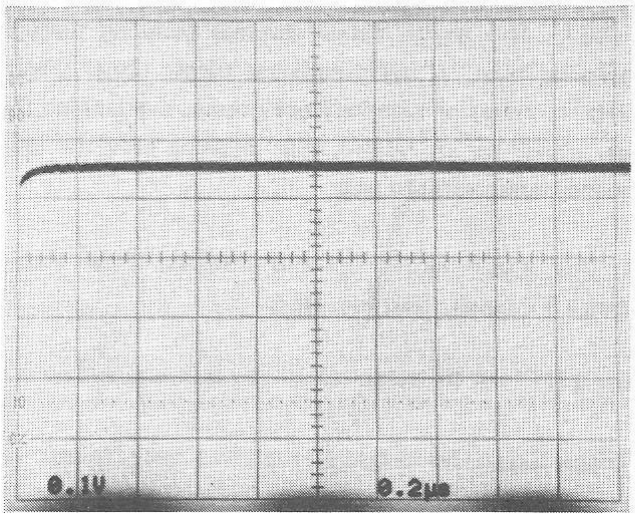
Adjust a trigger level. If triggering is properly done, A TRIG'D indicator will light up.

Figure 4-5-4. Level Adjustment (For "+" Slope)

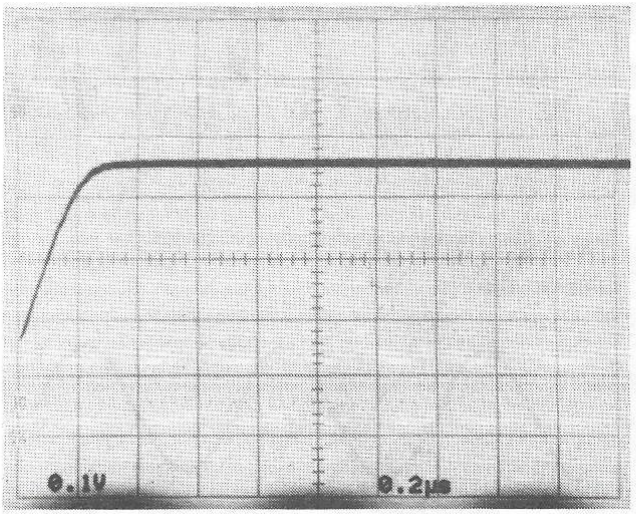
Midrange



Clockwise



Counterclockwise



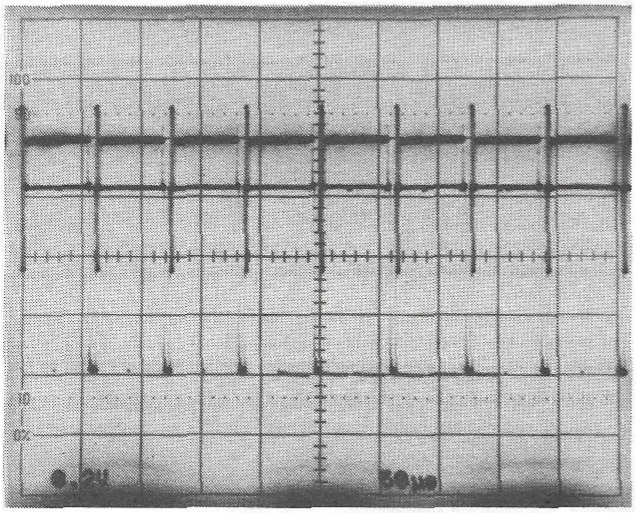
⑤ HOLDOFF adjustment

When observing a waveform of a complicated pulse sequence, the waveform to be measured may be doubled depending on sweep time setting, even if triggering is obtained.

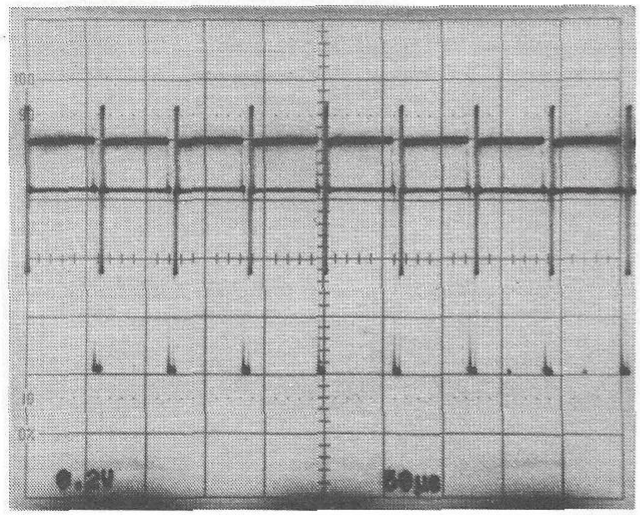
In this case, turn HOLDOFF in the INCREASE direction (clockwise) from its leftmost position to change a sweep cycle, and make adjustment so that the sweep will always start in a signal's basic cycle. Thus, the waveform is drawn in an easy-to-observe condition.

Figure 4-5-5. HOLDOFF

Before HOLDOFF Adjustment (Fully Turned to Left)



After HOLDOFF Adjustment



4-6 HORIZONTAL DEFLECTION SYSTEM

① MODE

Selects a mode.

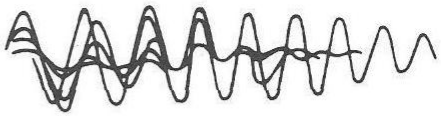
AUTO: Sweep free runs in the absence of a triggering signal. The triggering level changes only when the LEVEL control is adjusted to a new position.

NORM: Sweep is initiated when an adequate trigger signal is applied. When the trigger level is out of the trigger level range or when there is no trigger signal, sweeping stops.

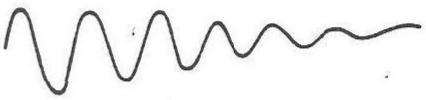
SINGLE: Sweep is initiated one time when an adequate trigger is applied. Sweep cannot be initiated again until the sweep logic is reset by pressing the SINGLE RESET .

Figure 4-6-1. Examples of Repetitive and Single Sweeps

a. Repetitive Sweep



b. Single Sweep

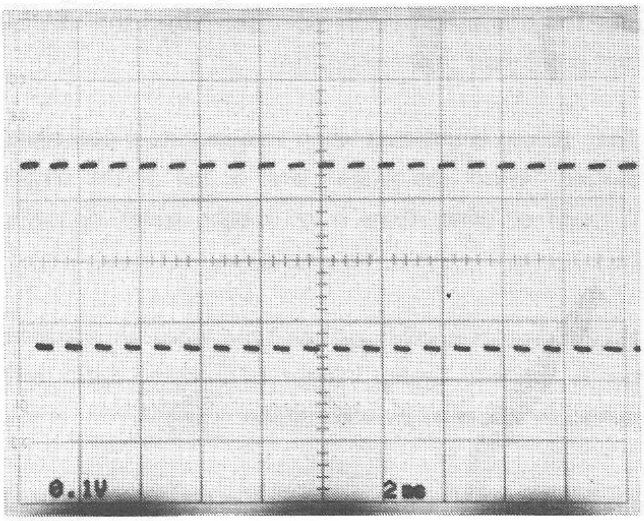


② A SEC/DIV

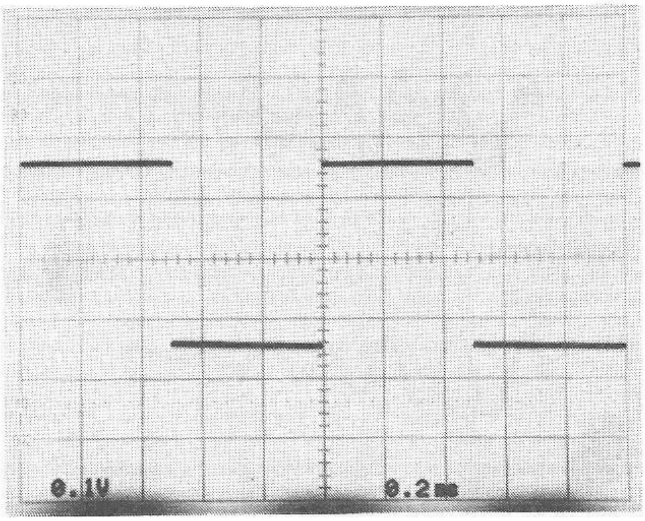
Changes a sweep time for A SWEEP. Select a range in accordance with an input signal in a 1-2-5 step sequence.

Figure 4-6-2. SEC/DIV

Delaying the Sweep Time



Speeding up the Sweep Time

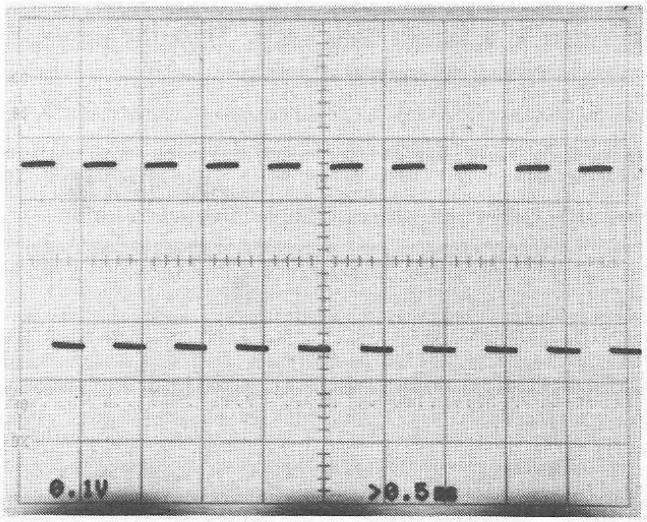


③ A VARIABLE

Fully turning this counterclockwise sets 1/2.5 or less.

Use of VARIABLE provides a display with an uncalibrated mark ">".

Figure 4-6-3. VARIABLE of SEC/DIV



④ ↔ **POSITION and FINE**

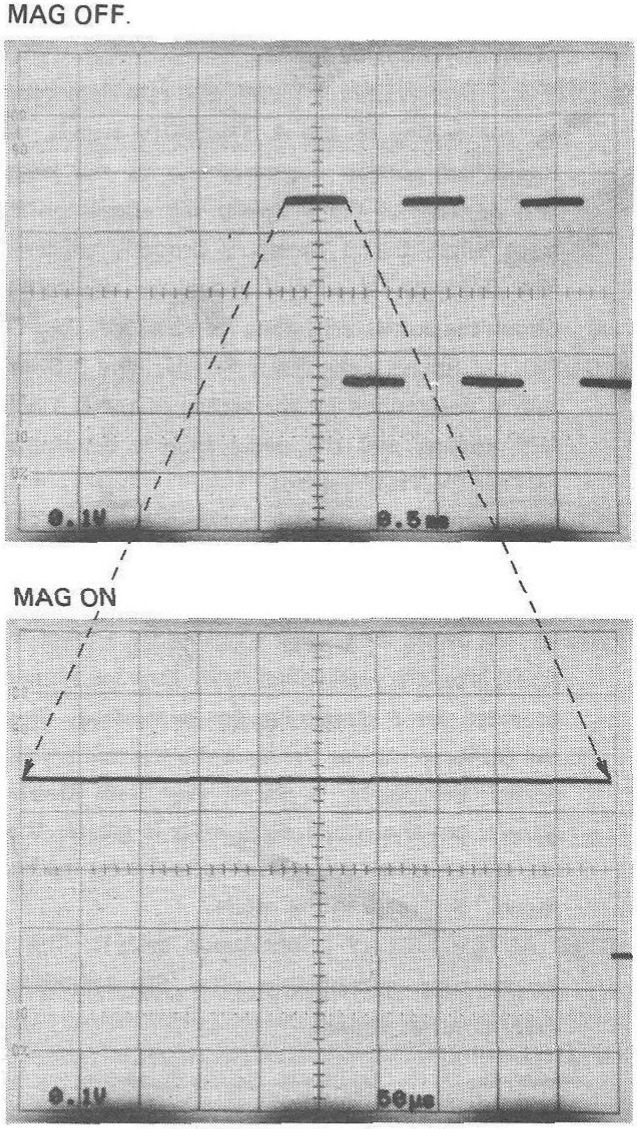
Adjusts a horizontal position.

↔ POSITION is for coarse adjustment and FINE is for fine adjustment.

⑤ **X10 MAG**

A waveform is enlarged from the center of the screen to the right and left by pulling to this side the horizontal position fine adjustment knob.

Figure 4-6-4. SEC/DIV Enlargement (X10 MAG)



⑥ HORIZ DISPLAY

A : Displays only the A Sweep. The horizontal deflection rate are determined by the setting of the A TIME/DIV switch.

A INTEN : Displays the A Sweep at a rate determined by the setting of the A TIME/DIV switch. An intensified portion corresponding to the length and position of the B Sweep will appear on the trace when the B Sweep is properly triggered. The INTENSITY control should be adjusted to obtain the proper brightness for viewing.

B DLY'D : Displays only the B Sweep. The B Sweep rate is determined by the setting of the B TIME/DIV switch, and the delay time is determined by DEALY TIME control.

ALT : Alternates the display between the A INTEN and B DLY'D sweeps. The TRACE SEPARTION control will position the B display vertically.

TRIG'D : B Sweep runs when triggered by a triggering signal after the established delay time has elapsed, provided the A Sweep has not terminated. Since the B Sweep runs at the time the triggering signal occurs, the display is stable, even with jittering signals; but the actual delay time is greater than the delay-time setting. Therefore, the crt readout shows " > " mark in this mode.

RUNS AFTER DELAY (Continuous delay): The B Sweep runs immediately after the established delay time has elapsed.

Setting the Delay Time:

If you set HORIZ DISPLAY to A INTEN, you can set the delay time with the rotary encoder.

When CURSORS has been already set, you can set to DELAY TIME with the Cursor Menu.

Fine adjustment is available when the FINE LED is lit up.

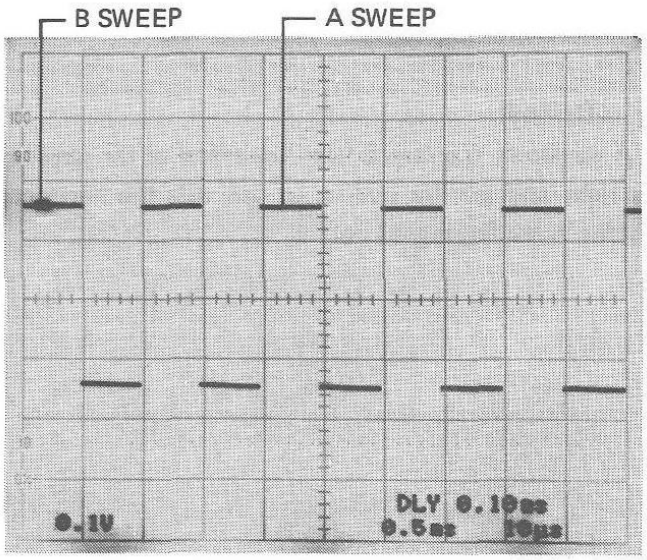
The delay sweep is a function which displays a signal to be measured on the screen, enlarging a point some time behind a sweep start point.

A delay sweep is determined by A SEC/DIV and DELAY TIME, and a magnification by a ratio of a SEC/DIV and B SEC/DIV.

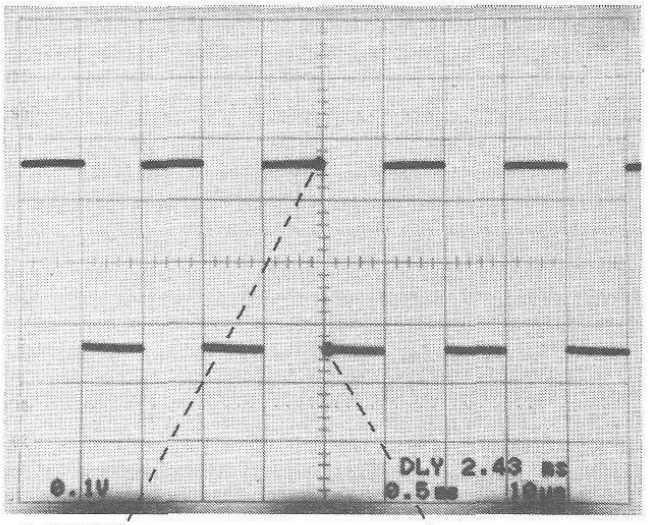
$$\text{Magnification} = \frac{\text{A SEC/DIV}}{\text{B SEC/DIV}}$$

Figure 4-6-5. HORIZ DISPLAY I (RUNS AFTER DELAY)

a. A INTEN



b. A INTEN (Continued)
Setting B SWEEP to Enlarging Position



c. B DLY'D

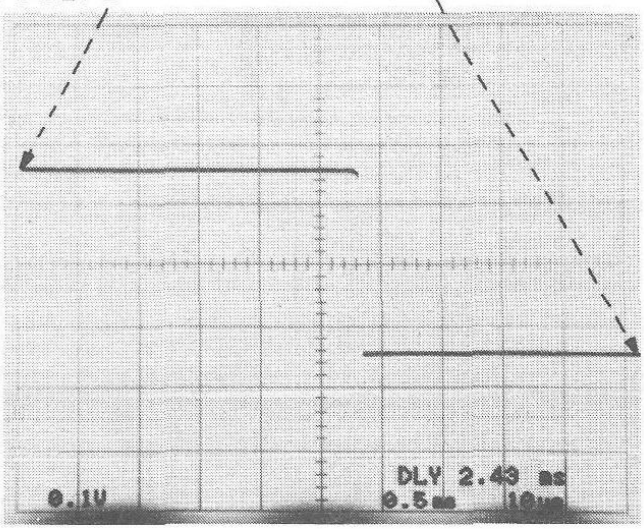
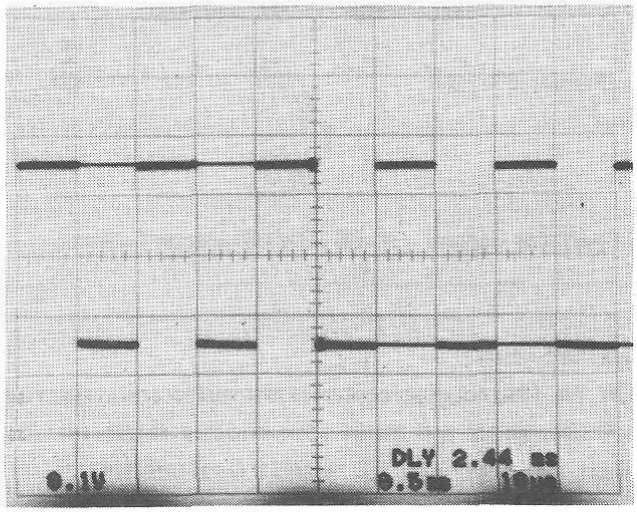


Figure 4-6-6. HORIZ DISPLAY I (Continued)

a. ALT (A INTEN and B DLY'D)



b. ALT (Continued)
Raising B DLY'D Position with TRACE SEP

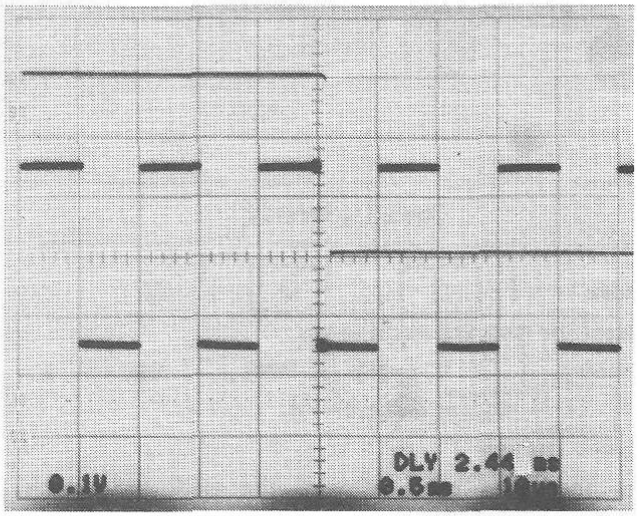
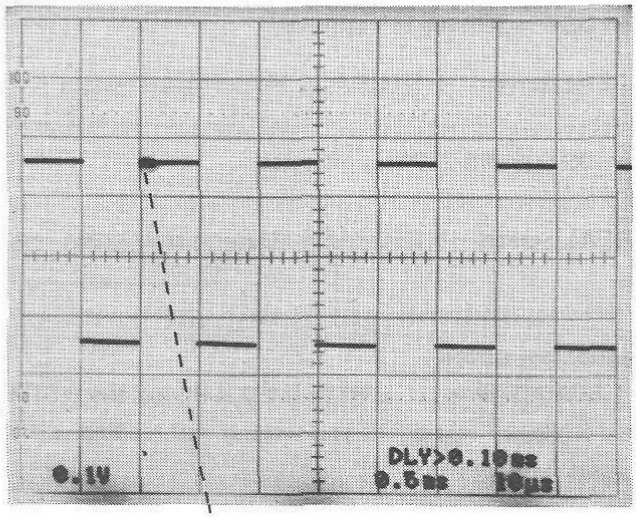
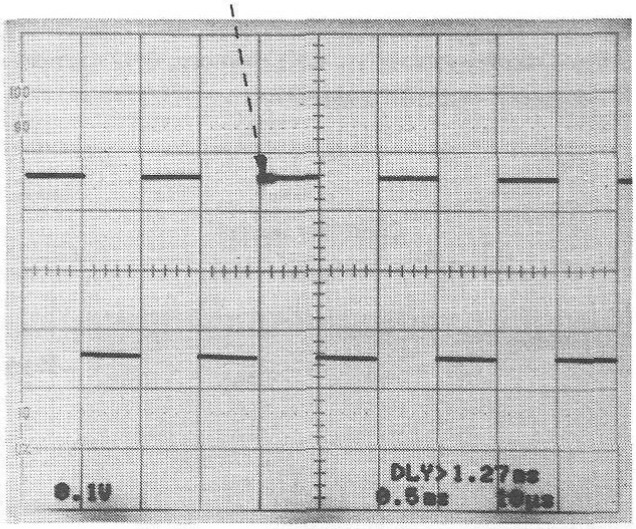


Figure 4-6-7. HORIZ DISPLAY II (TRIG'D)

a. A INTEN
Initial Setting



b. A INTEN (Continued)



Turning DELAY TIME (rotary encoder) clockwise makes the B sweep jump from the position in Fig. a to that in Fig. b.

4-7 STORAGE Modes

Every time [STORAGE] is pressed, the screen is changed over as follows:

When DS-504 (GP-IB) is mounted;

REAL Screen → STORAGE Measurement Screen → STORAGE Character Screen

When DS-505 (RS-232C) is mounted;

REAL Screen → STORAGE Measurement Screen → STORAGE Character Screen → RS-232C Character Screen

Measurement Screen

If RUN/STOP is set to RUN (LED is lit up), the WRITE BUSY indicator will blinks and writing and reading will be repeated.

When desiring to leave a written waveform on the screen as it is, press RUN/STOP to set the STOP mode (LED is lit off).

The STORAGE mode allows 4-phenomenon observation by using 4 display memories; CH1 memory, CH2 memory, REF 1 memory and REF 2 memory.

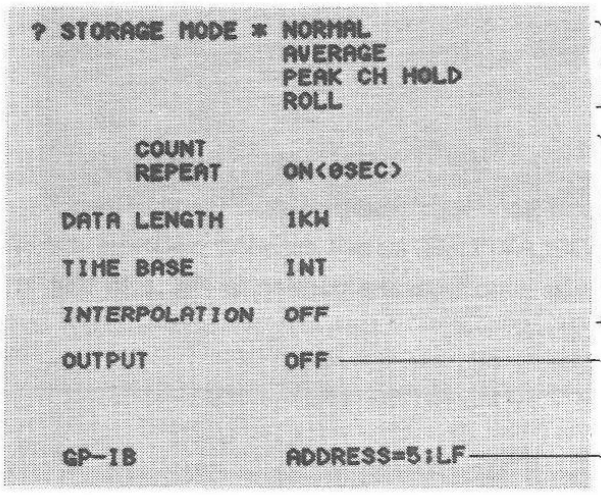
Character Screen

On the Character screen, select a mode and measuring conditions, using the Index keys and the rotary encoder

Next, pressing [RUN/STOP] starts a measurement.

Pressing [STORAGE] displays the Waveform screen in the STOP mode.

The following describes the Character screen and its operating method:

Character Screen	Operating Method
 [Note] This screen is displayed when DS-504 (GP-IB) is mounted.	• Index keys ([⇧] , [⇩]) Select the item you want to set. Pressing [⇧] moves a mark "?" upward, and [⇩] moves it downward. • Rotary encoder Set the items specified with the mark "?" (mode, measuring conditions, save and display of weveform, waveform output, GP-IB). *Mode setting . . . . . Specify with "*".* Other setting . . . . . A screen display changes. For details, see "4-7-5 to 4-7-12". • [RUN/STOP] key Every time [RUN/STOP] is pressed, the LED blinks. When the LED is lit up, measurement starts, and when the LED lights off, measurement stops.

CAUTION

- *When MAG for the horizontal deflection system is set to OFF (x 1) in the STORAGE mode, a horizontal position is fixed.*
- *When V. MODE is set to X-Y in the STORAGE mode, shift a vertical position with the following knobs.*

  CH1 (X) –CH2 (Y) . . . . . .
  CH1 STORAGE POSITION
  REF1 (X) –REF2 (Y) . . . . . .
  CH2 STORAGE POSITION

Four-phenomenon Observation When Using the REFERENCE Memory

Setting REF of the VERT MODE to ON allows 4-phenomenon observation (CH1 memory, CH2 memory, REF 1 memory, REF 2 memory).

Fig. 4-7-1 shows relations among the input memory, save and display memory.

If SET REF is pressed, the contents of CH1 and CH2 memory display will be shifted to REF 1 and REF 2 in accordance with setting of V. MODE.

Figure 4-7-2. Four-phenomenon Observation

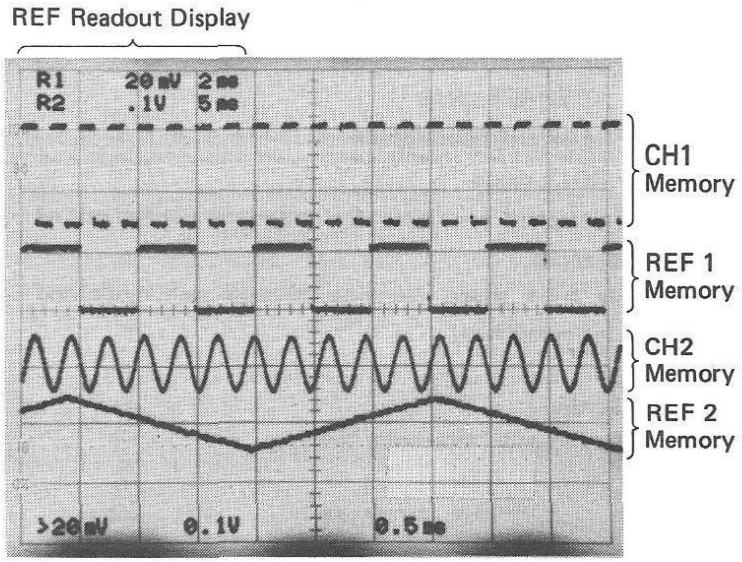
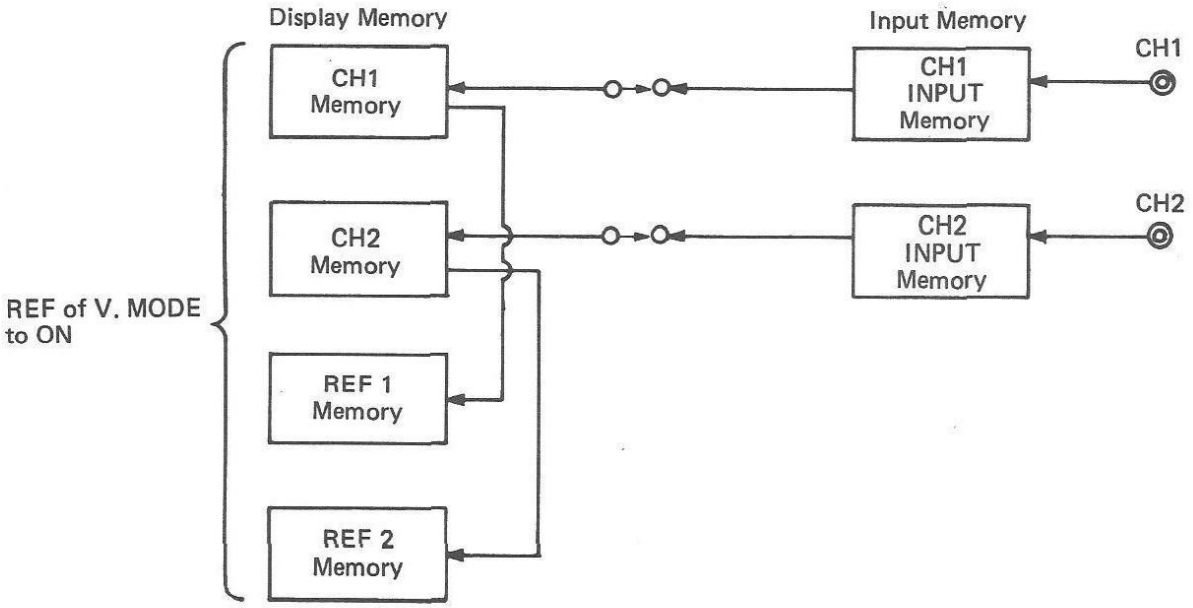


Figure 4-7-1. Display Memory Block Diagram



Mode Types

There are the following four STORAGE modes:

a. NORM (NORMAL) mode
b. AVERAGE mode
c. PEAK CH HOLD mode
d. ROLL mode

Set measuring conditions for one mode selected out of the four above.

Table 4-7-1 shows relations between each mode and measuring conditions.

Mode Setting

Rotary Encoder Operating Method

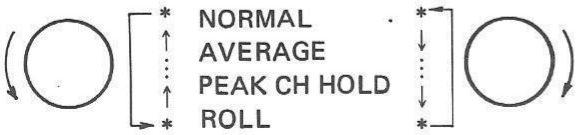


Table 4-7-1

Item \ Mode		NORM	AVERAGE	PEAK CH HOLD	ROLL
Measuring Conditions	COUNT	X	O	O	X
	REPEAT	O	O	O	X
	DATA LENGTH	O	O	O	X
	TIME BASE	O	O	O	X
	INTERPOLATION	O	O	X	X
Hard Copy	OUTPUT	O	O	O	O
GP-IB	GP-IB	O	O	O	O

O : Can be set
X : Cannot be set

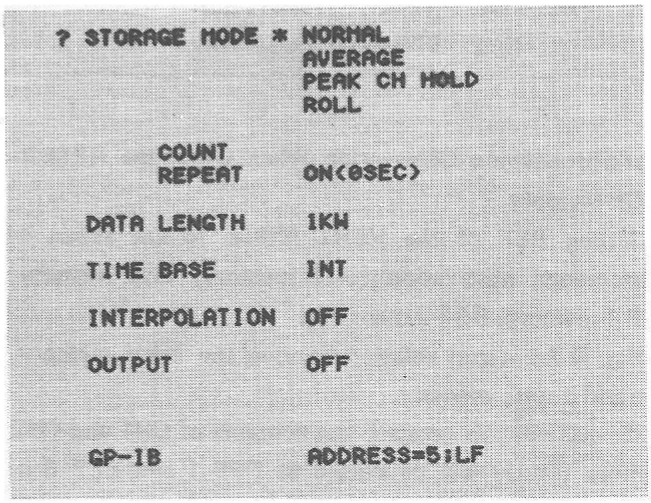
Mode Selecting

4-7-1 NORMAL Mode

This mode is for normal measurement.

Procedure

① Set a "*" mark to NORMAL.
② Set measuring conditions
③ Press RUN/STOP .



4-7-2 AVERAGE Mode

Averaging is used when increasing a signal S/N ratio. That is, this is used when you want to decrease only noise components of the repetition signal containing noises. However, it requires the trigger signal synchronous with the repetition signal.

The number of averaging times which can be set is 2, 4, 8, 16, 32, 64, 128 and 256.

Procedure

① Set the "*" mark to AVERAGE.
② Set measuring conditions
③ Press RUN/STOP .
Press RUN/STOP when stopping halfway.

Averaging Method

Perform simple averaging at 2^n.

A noise component rejection rate is in proportion to the square root $\sqrt{N}$ of the number of averaging times N.

For example, assuming that the number of averaging times is 32, noises are reduced to 1/1.5 (15 dB).

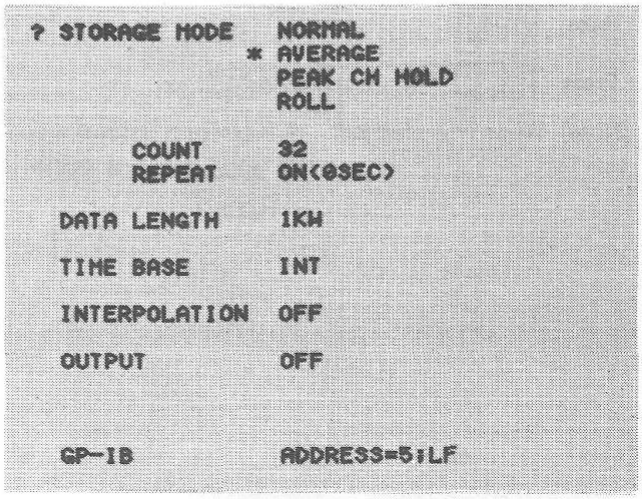
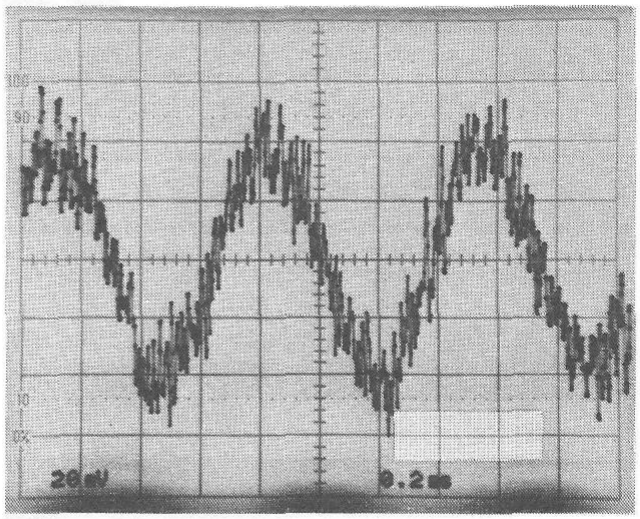
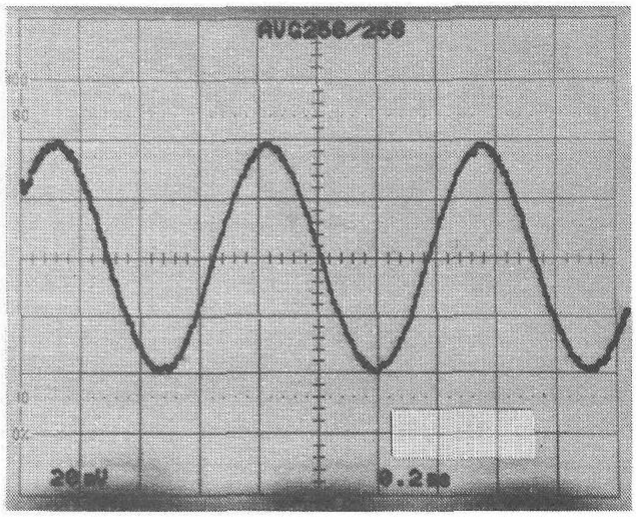


Figure 4-7-2. AVERAGE

AVERAGE OFF



AVERAGE ON (256 Times)



4-7-3 PEAK CH HOLD Mode

This mode performs MAX or MIN processing per sampling and holds it. It is effective for glitch detection and measurement of a frequency change.

The number of waveform fetch times which can be set is 2, 4, 8, 16, 32, 64, 128, 256 and ∞.

Procedure

① Set the "*" mark to PEAK CH HOLD.

② Set measuring conditions.

③ Press [RUN/STOP] .

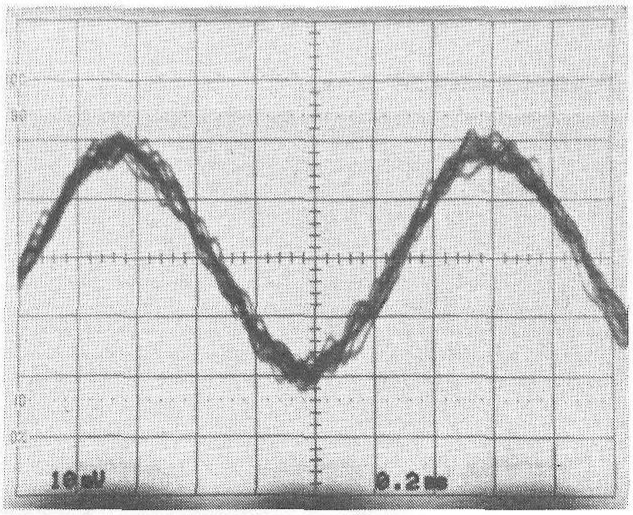
Press [RUN/STOP] when stopping halfway.

[Note] When ∞ is selected: A waveform is continuously taken in until STOP is pressed.

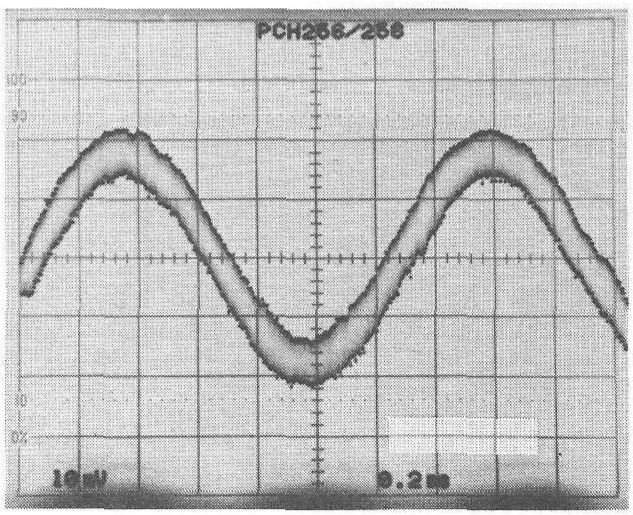
```
? STORAGE MODE    NORMAL
                  AVERAGE
                * PEAK CH HOLD
                  ROLL

      COUNT       32
      REPEAT      ON(0SEC)

DATA LENGTH       1KW

TIME BASE         INT

INTERPOLATION

OUTPUT            OFF


GP-IB             ADDRESS=5:LF
```

Figure 4-7-3. PEAK CH HOLD

REAL



PEAK CH HOLD ON (256 Times)



4-7-4 ROLL Mode

If an input signal is written with a slow-repetition clock (slow SEC/DIV range), writing takes a considerable time and it cannot be observed what signals are being input during that time.

In the ROLL mode, every time one word worth of data is written, new data is displayed on the right end of the screen and the data taken in is sequentially shifted word by word to the left, thus facilitating observation of an input signal with a slow clock.

Setting the ROLL mode reduces the sweep time to 1/1,000. Table 4-7-4 shows time relations between the REAL and ROLL modes.

Table 4-7-4

Mode	Sweep Time											
ROLL mode excluded	0.1μs to 0.1ms	0.2ms	0.5ms	1ms	2ms	5ms	10 ms	20ms	50ms	0.1 s	0.2 s	0.5 s
ROLL mode	0.1 s	0.2 s	0.5 s	1 s	2 s	5 s	10 s	20 s	50 s	100 s	200 s	500 s

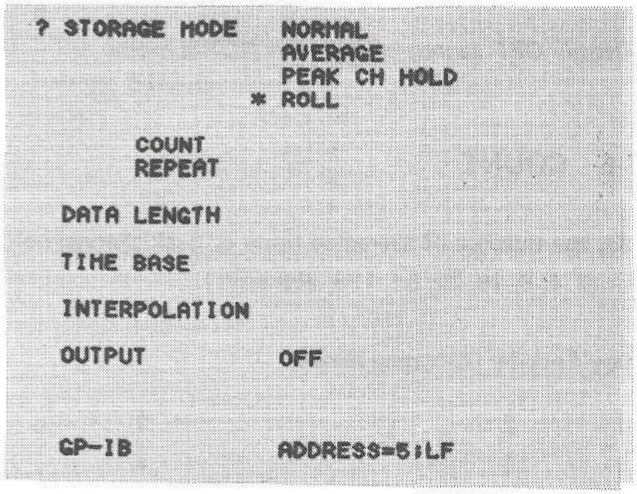
Procedure

① Set the "*" mark to ROLL

② Press RUN/STOP

[Note] The following cursor measurements are possible in the ROLL mode.

- ΔVOLTAGE
- ΔTIME
- VOLTAGE RATIO
- PHASE

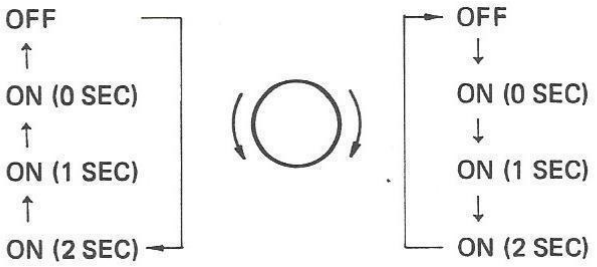


Setting the Measuring Conditions

4-7-5 REPEAT

Select time interval OFF/ON (0 sec, 1 sec, 2 sec) from the end of measurement to the start of next measurement.

Rotary Encoder Operating Method

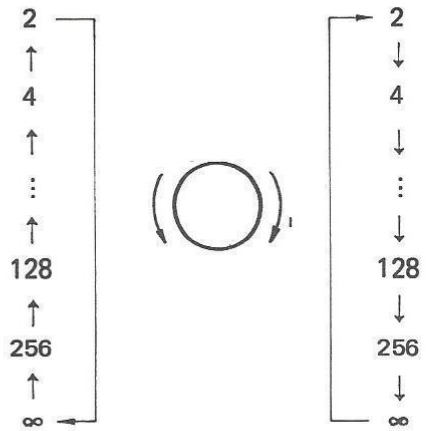


[Note] OFF cannot be set in the NORM mode.

4-7-6 COUNT

Set the number of averaging times or peak channel hold times (2, 4, 8, 16, 32, 64, 128, 256 or ∞).

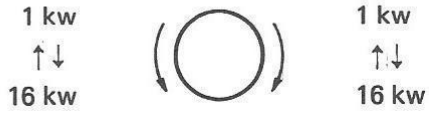
Rotary Encoder Operating Method



4-7-7 DATA LENGTH

Select a data length (1 k words, 16 k words).

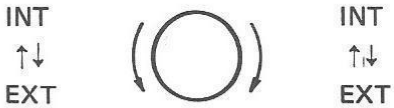
Rotary Encoder Operating Method



4-7-8 TIME BASE

Select internal or external clocks.

Rotary Encoder Operating Method



When using the external clock, connect a clock signal to EXT CLK IN of the rear panel.

CAUTION

A maximum input voltage for EXT CLK IN is ±50 V.

Do not apply a higher voltage.

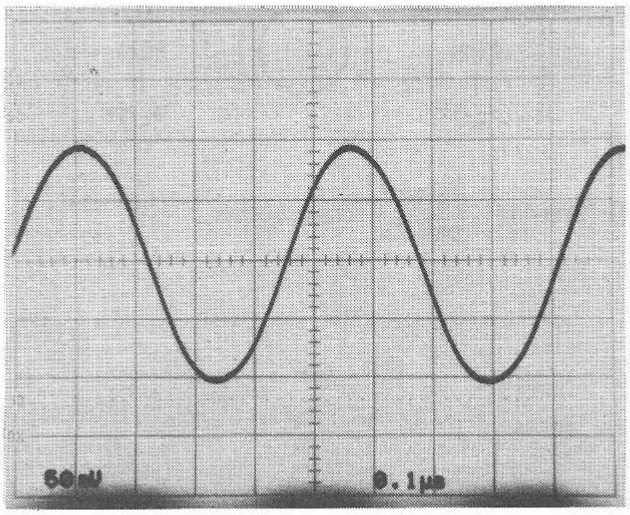
4-7-9 INTERPOLATION

When the ranges from 0.2 μs/div to 50 ns/div are used or a waveform is enlarged, data quantity is reduced. This feature interpolates between data with a line or sine.

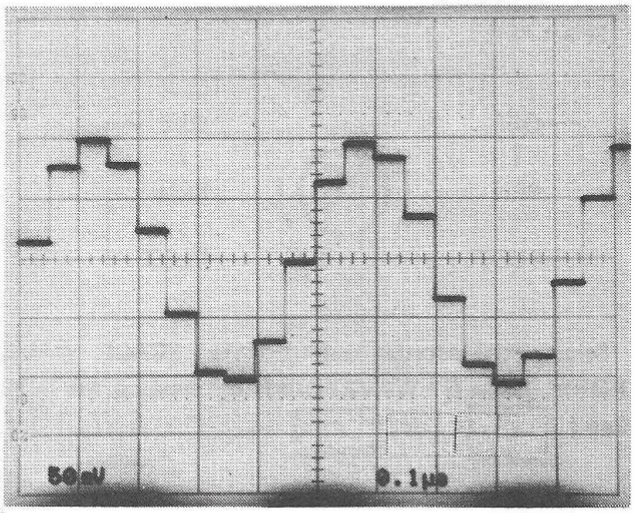
Rotary Encoder Operating Method

Figure 4-7-9. INTERPOLATION

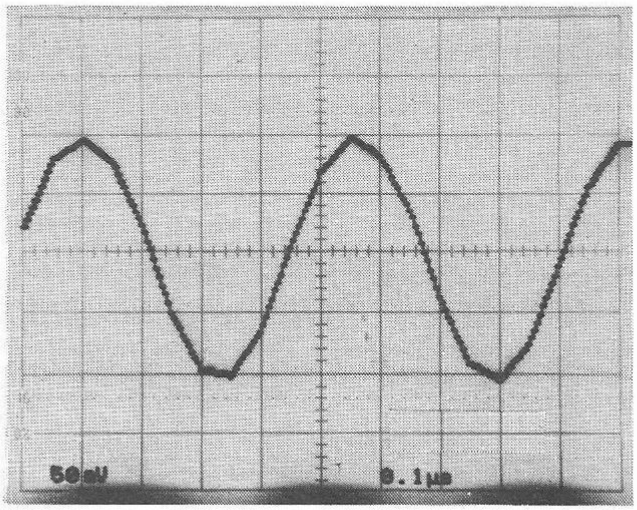
Input Signal (REAL Mode)



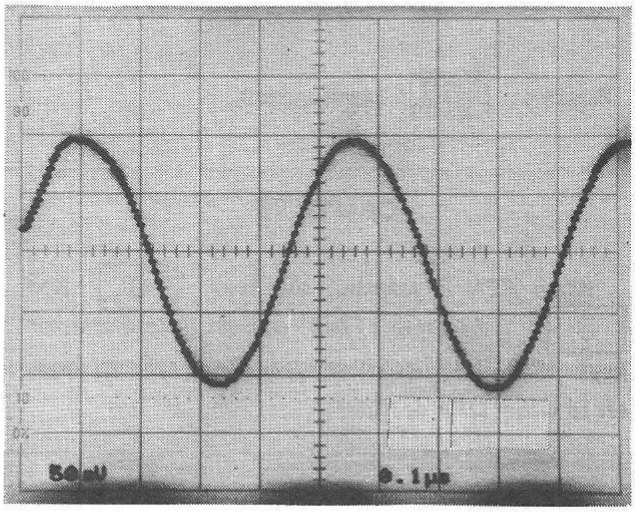
No Interpolation



Linear Interpolation



Sine Interpolation



Hard Copy

4-7-10 OUTPUT

There are two output methods; one is to output to the pen recorder through no interface, and the other is to output to the plotter (HP-GL format) with the interface (GP-IB or RS232C).

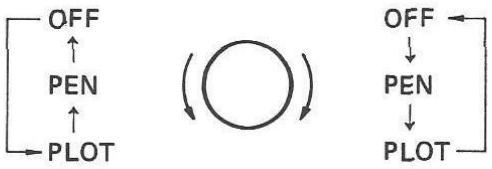
a. Pen Recorder Output

Procedure

① Connect X OUT, Y OUT and PEN UP OUT on the rear panel to X INPUT, Y INPUT and PEN UP INPUT of the pen recorder, using respective cables.

② Set the "?" mark to OUTPUT.

③ Select PEN.



④ Select pen recorder output (CAL, SCALE, WAVEFORM, SCALE + WAVEFORM) by pressing the index key (⇧ or ⇩)

PEN . . . . . * CAL
SCALE
WAVEFORM
SCALE +
WAVEFORM

⑤ Pressing RUN/STOP starts output.

CAUTION

When PEN is selected, the keys ⇧ and ⇩ function as pen recorder output selector keys. When you use these keys as item selector keys, set to either OFF or PLOT.

b. Plotter Output

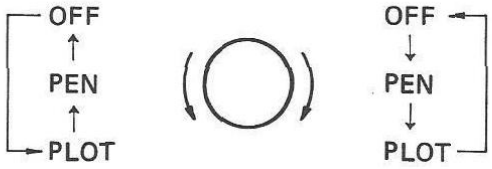
Procedure

① Connect to the plotter with a GP-IB cable or RS-232C cable.

② Set as follows when outputting with GP-IB.
Instrument : Talk Only
Plotter : Listen Only

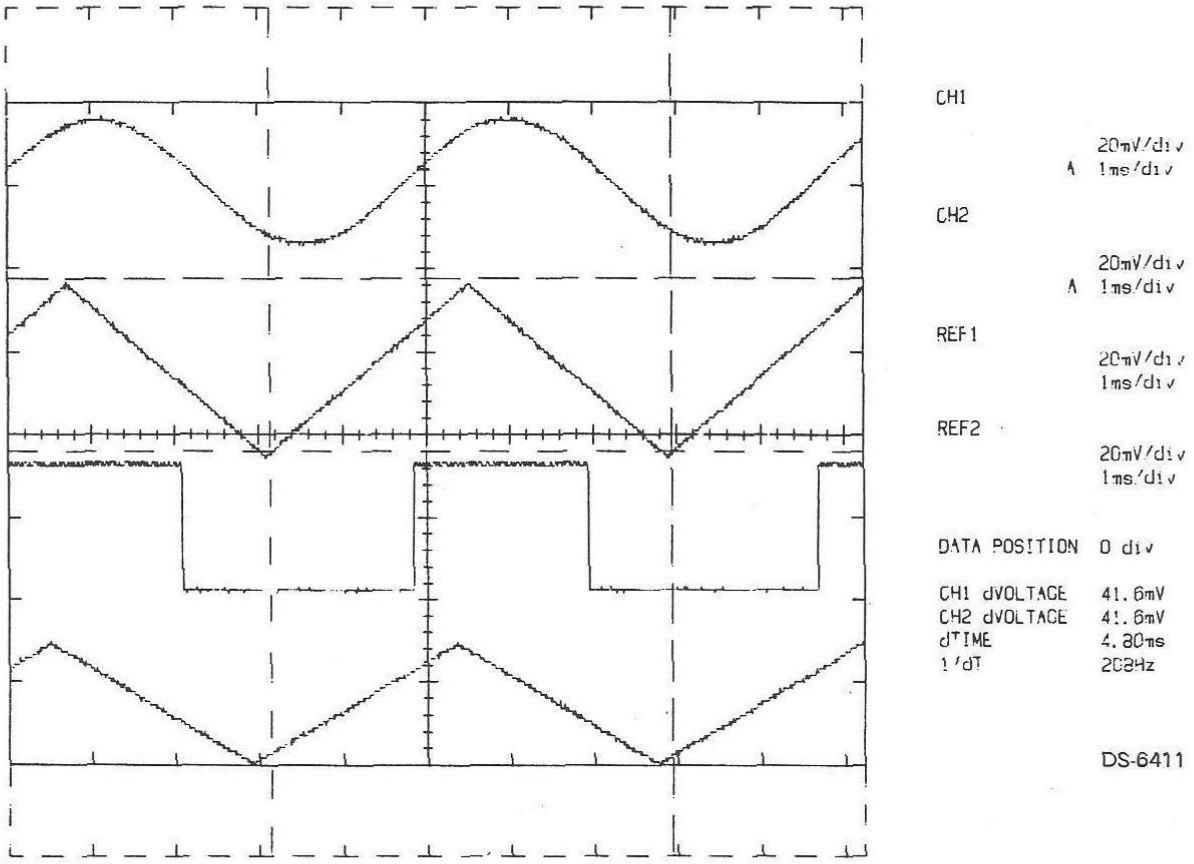
③ Set the "?" mark to OUTPUT.

④ Select PLOT.



⑤ Pressing RUN/STOP starts output.

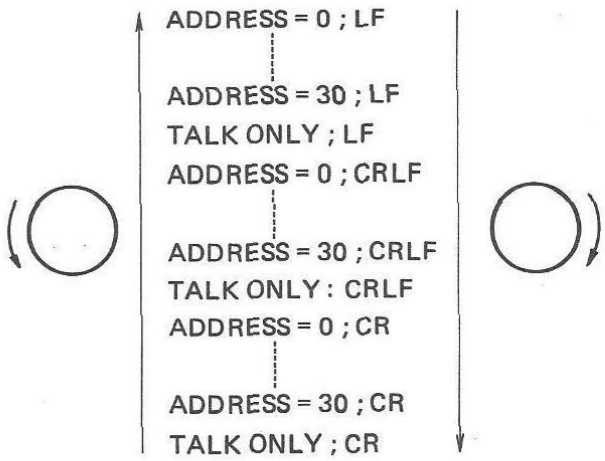
Figure 4-7-12. Plotter Output Example



Interface

4-7-11 GP-IB (OPTION)

Set GP-IB address, delimiter and TALK ONLY.

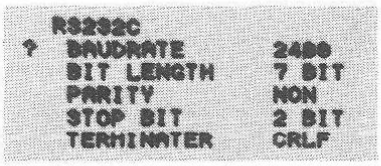


For details, see "Section 5 GP-IB".

4-7-12 RS-232C (OPTION)

Select RS-232C communication parameters with the Index kesy (⇧ , ⇩) and rotary encoder.

Figure 4-7-14. RS-232C Character Screen



4-8 MEASUREMENT BY CURSORS

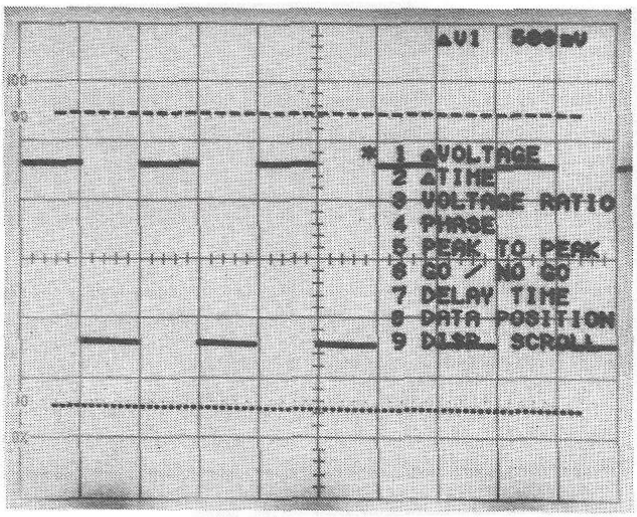
The following measurements can be done:

1 ΔVOLTAGE . . . . . .
Potential difference between cursors
2 ΔTIME . . . . . Time between cursors
1 and 2 ΔVOLTAGE and ΔTIME . . . . . .
Potential difference and time between cursors
3 VOLTAGE RATIO . . . . . Potential difference ratio
4 PHASE . . . . . Phase between cursors
5 PEAK TO PEAK . . . . . .
Difference between +Peak and –Peak between cursors
6 GO/NO GO . . . . . .
Judgment whether inside or outside the specified range
7 DELAY TIME . . . . . Delay time
8 DATA POSITION . . . . . Minus delay
9 DISP SCROLL . . . . . .
Enlargement of a stored waveform (stop state)

Operating Method

Display the menu screen (see Fig. 4-8).

Figure 4-8. Menu Screen



How to display the menu screen .

When cursor is set to OFF (light off):

Press the [CURSOR] to light up.

Every time [CURSOR] is pressed, ON/OFF is switched.

When [CURSOR] is set to ON (light up):

Press index keys ([⇧] , [⇩])

Measure with following keys and rotary encoder on menu screen.

○ Index keys [⇧] and [⇩]

Select the item to be measured.

Pressing [⇧] moves the "*" mark upward and pressing [⇩] moves it downward.

○ [C1] and [C2] keys

Every time [C1] or [C2] is pressed, ON/OFF is changed over.

[C1] lit up: A broken line (— — — —) moves by operating the rotary encoder.

[C2] lit up: A dotted line (. . . . . .) moves by operating the rotary encoder.

Both [C1] and [C2] lit up: The broken line and dotted line simultaneously move by operating the rotary encoder.

○ Rotary encoder

The cursors are moved upward or to the right by turning clockwise, and downward or to the left by turning counterclockwise at measurement items 1 to 8. With FINE turned on, fine adjustment is available.

○ [REAL] key

REAL mode when the LED is lit up.

Switches between the REAL mode and STORAGE mode.

○ [STORAGE] key

STORAGE mode when the LED is lit up.

Switches between the REAL mode and STORAGE mode.

○ [RUN/STOP] key

Every time [RUN/STOP] is pressed, RUN/STOP is switched over. Selecting RUN (LED lit up) starts measurement.

Selecting STOP (LED lit off) stops measurement.

Table 4-8 shows cursor measurement enabled item at REAL (STORAGE OFF) and STORAGE.

Table 4-8

Measurement Item	REAL	STORAGE
1. ΔVOLTAGE	○	○
2. ΔTIME	○	○
3. VOLTAGE RATIO	○	○
4. PHASE	○	○
5. PEAK TO PEAK	—	○
6. GO/NOGO	—	○
7. DELAY TIME	○*1	○*1
8. DATA POSITION	—	○
9. DISP SCROLL	—	○

*1 Set HORIZ DISPLAY to A INTEN.

○ : measurement enabled

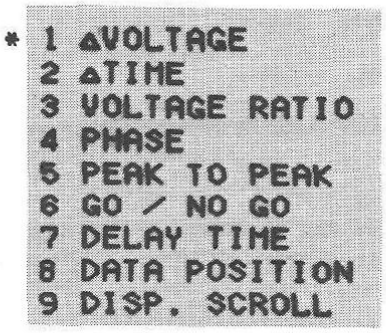
— : measurement unenabled

4-8-1 ΔVOLTAGE

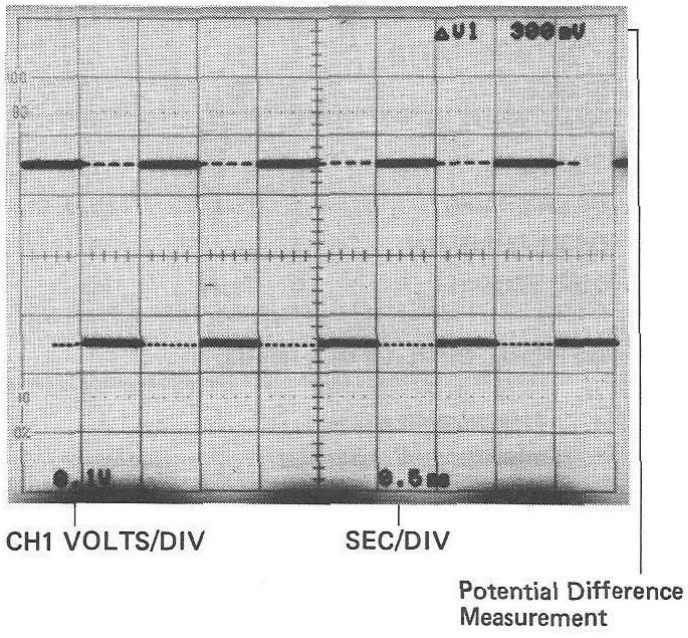
Measures a potential difference between two cursors.

Procedure

① On the Guide Menu screen, set the "*" mark to 1 ΔVOLTAGE.



② Set the cursors to positions to be measured.

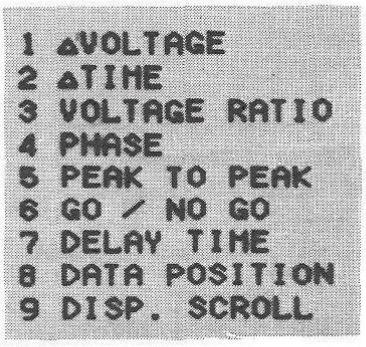


4-8-2 ΔTIME

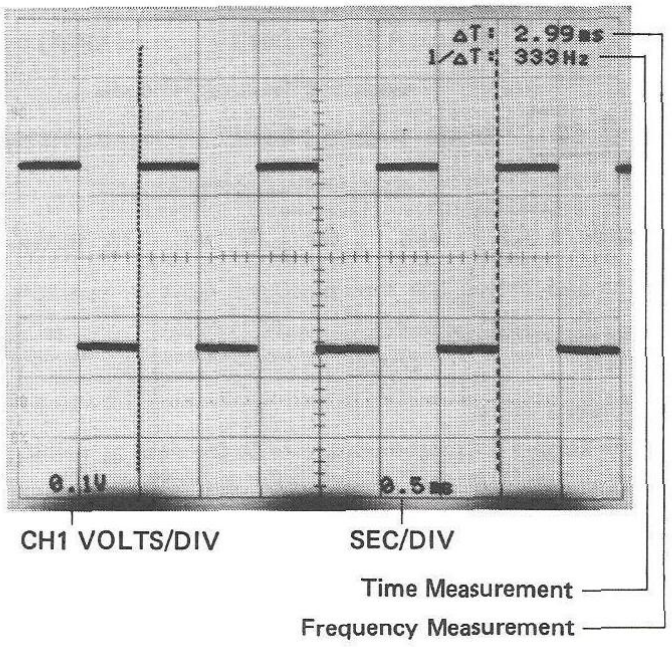
Measures a time between two cursors and its reciprocal (frequency).

Procedure

① On the Guide Menu screen, set the "*" mark to 2 ΔTIME.



② Set the cursors to positions to be measured.



CAUTION

REAL: SEC/DIV is set to UNCAL, ΔT will be displayed with ">" and 1/ΔT will be displayed with "<".

STORAGE: SEC/DIV is fixed.
VARIABLE does not work.

Measured Value Display of ΔT and 1/ΔT

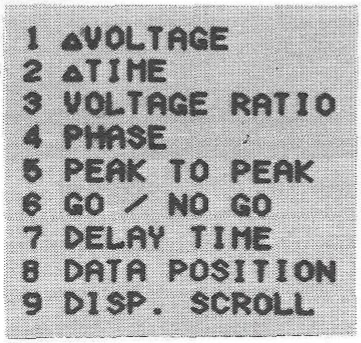
Although cursor resolution has 4,096 bits, it is displayed in 3 digits (cut less than 4th digit off). Therefore, there may be an error of up to 1% between measured values of ΔT and 1/ΔT.

4-8-3 ΔVOLTAGE and ΔTIME

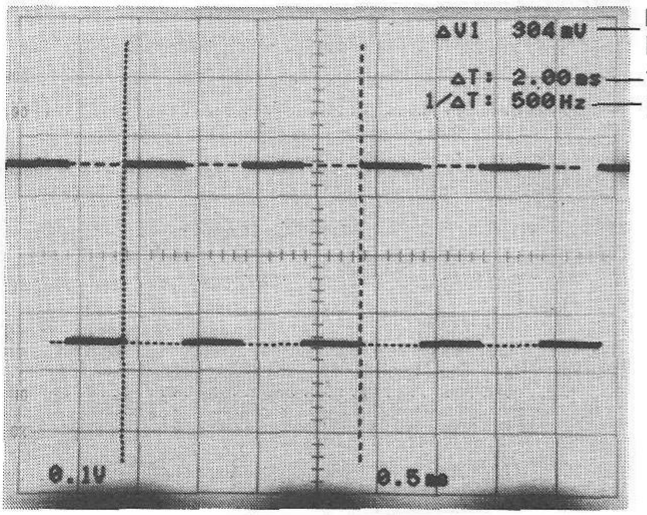
Simultaneously measures a potential difference and a time.

Procedure

① On the Guide Menu screen, set the "*" mark to 1 ΔVOLTAGE and 2 ΔTIME.



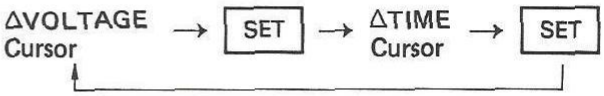
② Adjust the cursors to positions to be measured.



Potential Difference Measurement
Time Measurement
Frequency Measurement

Rotary Encoder Using Method

Pressing SET switches over the cursors (ΔVOLTAGE and ΔTIME) which can be set by the rotary encoder.



CAUTION

REAL: If SEC/DIV is set to UNCAL, ΔT will be displayed with ">" and 1/ΔT will be displayed with "<".

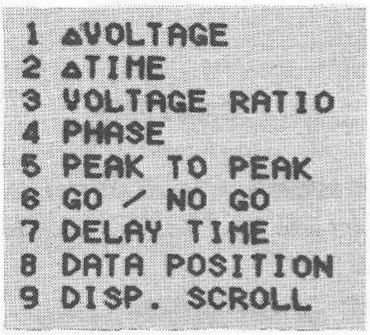
STORAGE: SEC/DIV is fixed.
VARIABLE does not work.

4-8-4 VOLTAGE RATIO

Measures a ratio to a reference potential.

Procedure

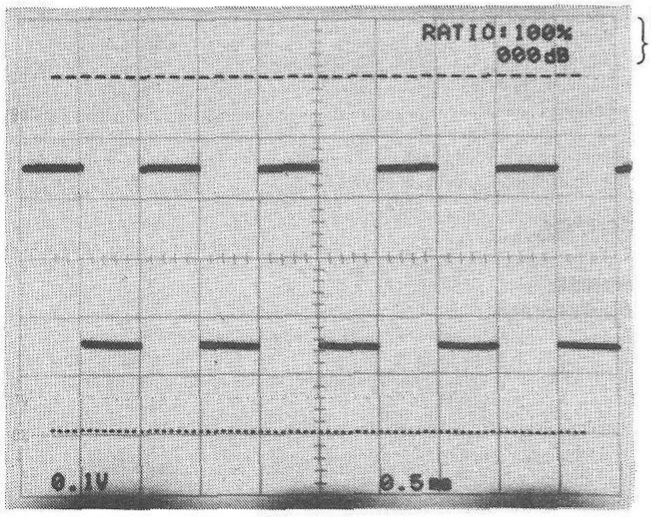
① On the Guide Menu screen, set the "*" mark to 3 VOLTAGE RATIO.



② Set a reference potential with two cursors.

③ Press [SET] .

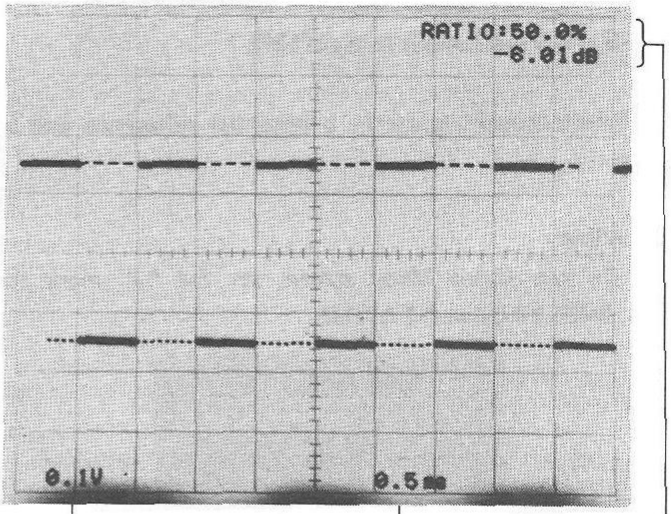
This sets an inter-cursor ratio to 100% and 0 dB.



} Setting of 6 Divisions between 2 Cursors as Reference Value

④ Set the cursors to positions to be measured.

Measure a ratio to 6 divisions between the cursors set in ③ .



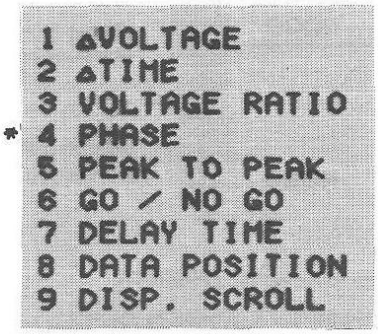
CH1 VOLTS/DIV SEC/DIV Voltage Ratio Measurement

4-8-5 PHASE

Measures a phase difference from a reference waveform.

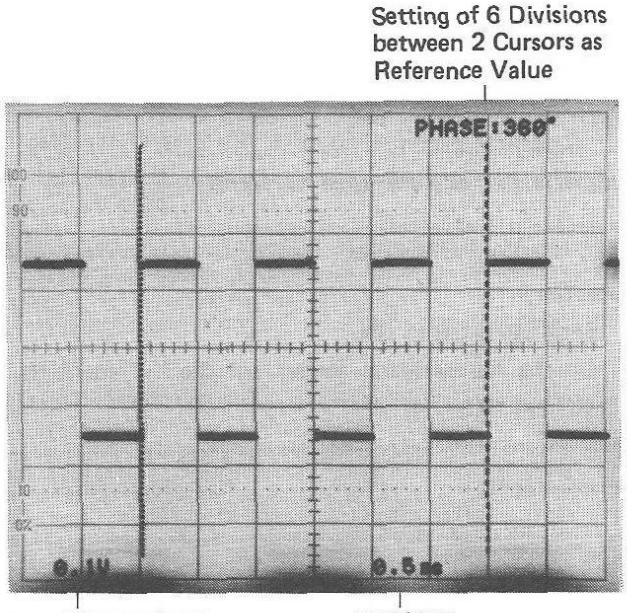
Procedure

① On the Guide Menu screen, set the "*" mark to 4 PHASE.

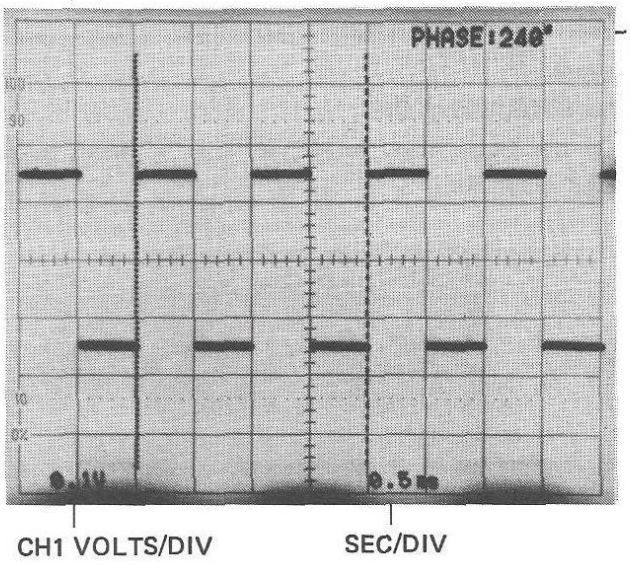


② Set two cursors to reference positions.

③ Press [SET] to set an inter-cursor phase to 360°.



④ Set the cursors to positions to be measured.



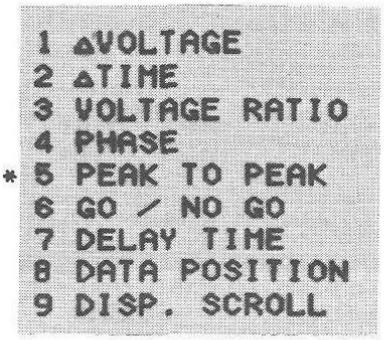
4-8-6 PEAK TO PEAK

Measures the difference from maximum to minimum values between two cursors.

Procedure

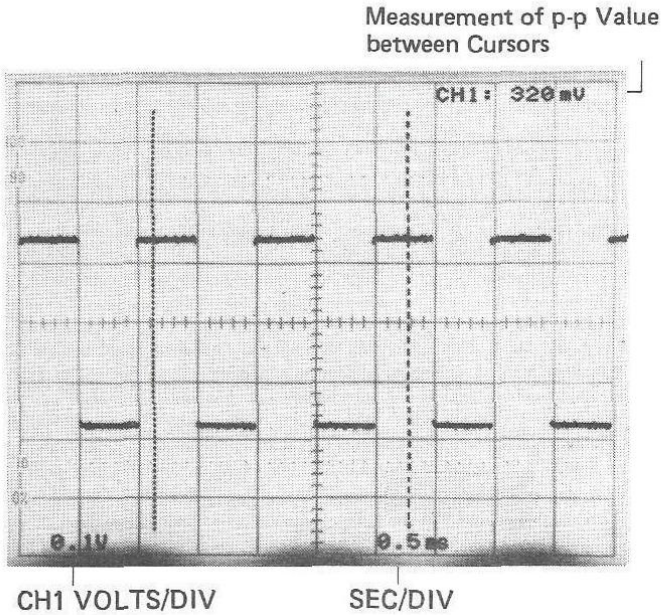
① Set STORAGE to ON.

② On the Guide Menu screen, set the "*" mark to 5 PEAK TO PEAK.



③ Set the cursors to positions to be measured.

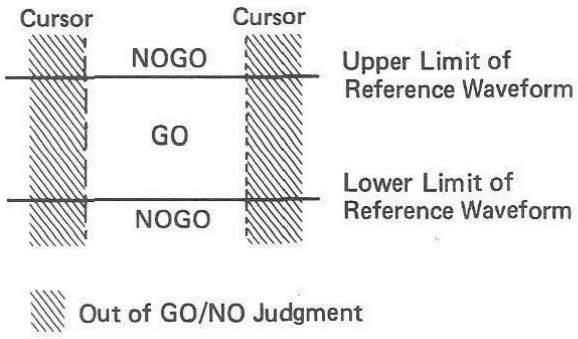
④ Set RUN/STOP to RUN.



4-8-9 GO/NO GO

Judges whether or not a measured waveform is within a preset range.

Set a judgment area with two vertical cursors and a reference waveform width.



A reference waveform changes depending on V. MODE setting.

For CH1 . . . . . REF 1 as a reference
For CH2 . . . . . REF 2 as a reference
For DUAL . . . . . REF 1 as a reference

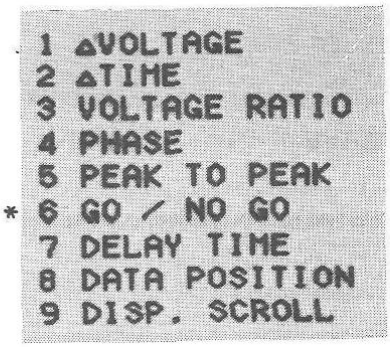
CAUTION

Judgment becomes unstable if a greatly changing signal is used as a reference waveform.

Procedure

① Set STORAGE to ON.

② On the Guide menu screen, set the "*" mark to 6 GO/NO GO.



③ Reference memory readout is displayed. (See the figure on the right)

④ Pressing [SET REF] stores the reference waveforms in the reference memory and displayes them on the screen. (See the figure on the right.)

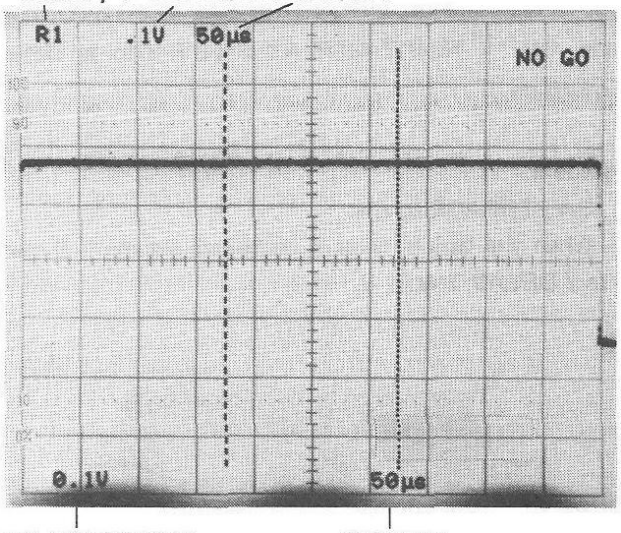
⑤ Using the rotary encoder, set a HORIZ. axis NO GO range (cursor displays).

⑥ Press [SET] .

⑦ Using the rotary encoder, set the vertical axis NO GO range (waveform display).

⑧ Set [RUN/STOP] to RUN.

Reference Memory Readout Display



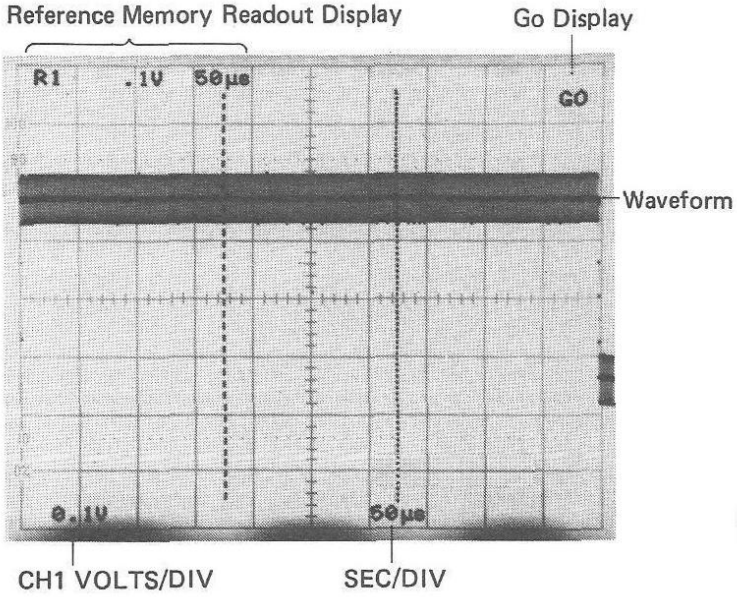
- Rotary Encoder Using Method

The NO GO ranges (vertical axis and horizontal axis) which can be set with the rotary encoder are switched every time [SET] is pressed.

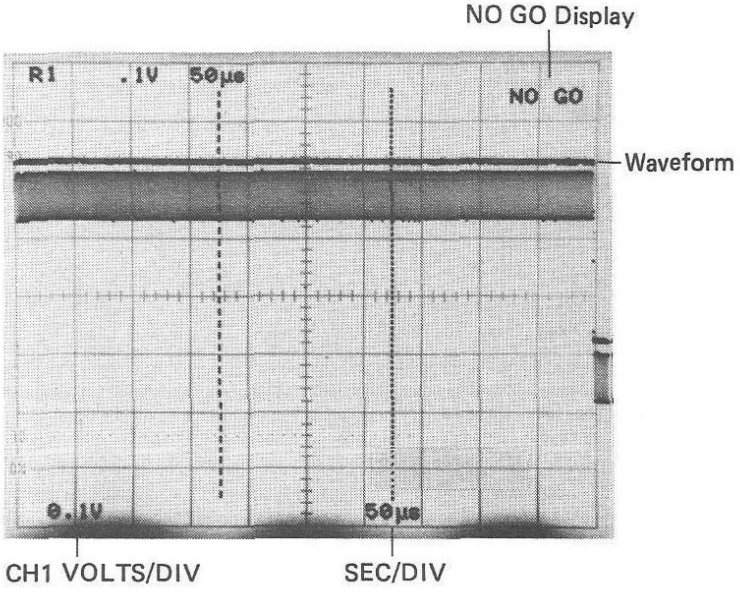
Cursor Setting → [SET] → Setting of width of reference waveform → [SET]

Figure 4-8-8. GO/NO GO Judgment

Judged as GO because the waveform is within an area and the cursors



Judged as NO GO because the waveform is not within area and the cursors



[Note] If STORAGE POSITION is turned, the vertical position seems to be changed. Also, if STORAGE VARIABLE is turned, the vertical deflection factor seems to be changed. However, these are not actually changed and they do not affect GO/NO GO judgement. GO/NO GO judgement is done by the original waveform.

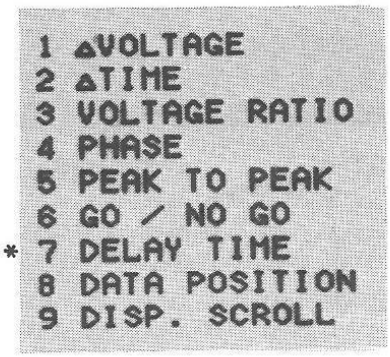
4-8-8 DELAY TIME

A INTEN and B DLY'D can be used in the STORAGE mode. See ⑥ HORIZ DISPLAY in 4-6 Horizontal Deflection System.

Procedure

① Set STORAGE to ON.

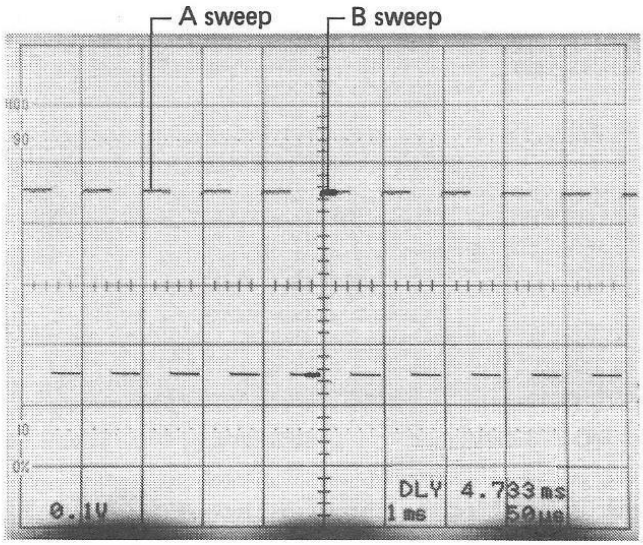
② When the Guide menu is displayed, set the "*" mark to 7 DELAY TIME.



When the Guide menu is not displayed, set HORIZ DISPLAY to A INTEN to select 9 DELAY TIME.

③ Set a delay time with the rotary encoder. In case of the following figure, set DLY = 4.73 ms.

A INTEN



④ Setting HORIZ DISPLAY to B DLY'D, B sweep is enlarged on the screen.

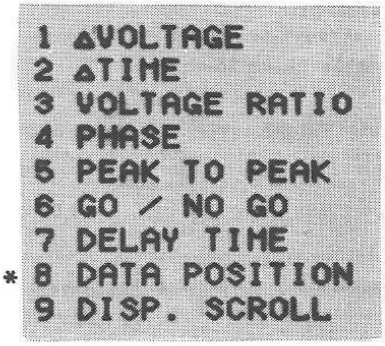
4-8-9 DATA POSITION

Measures a phenomenon before a trigger point (minus display).

Procedure

① Set STORAGE to ON.

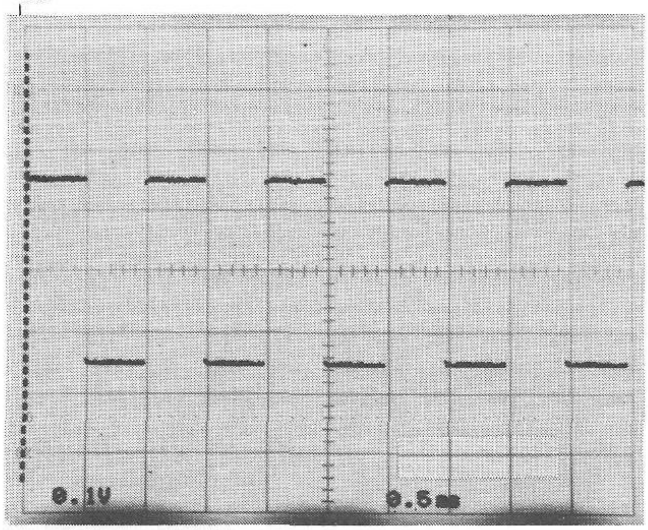
② On the Guide Menu screen, set the "*" mark to 8 DATA POSITION.



③ Set the cursors to positions to be measured. The trigger point changes by 1 division.

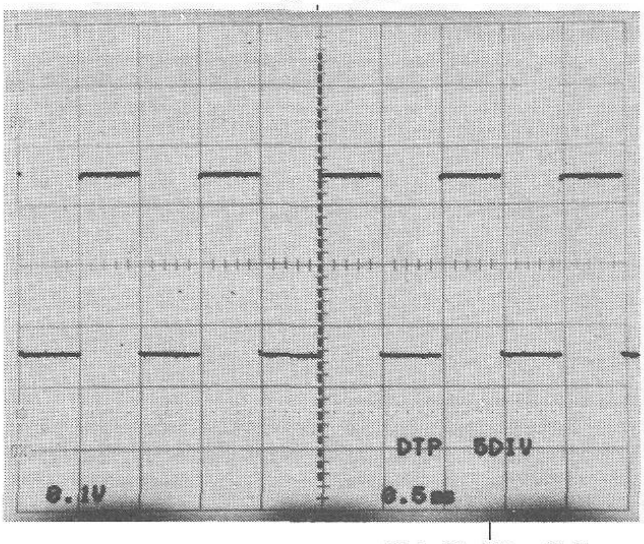
a. Measuring after Trigger Point

Trigger Point



b. Measuring 5 Divisions before Trigger Point

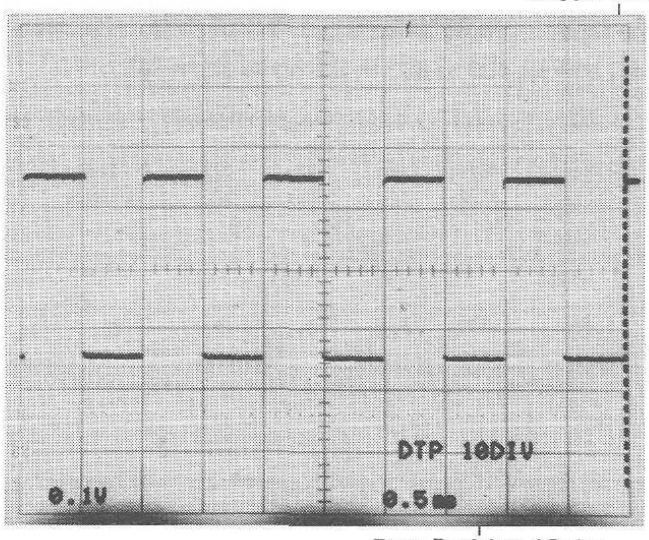
Trigger Point



Data Position 5 div

c. Measuring 10 Divisions before Trigger Point

Trigger Point



Data Position 10 div

Combined Use with DELAY TIME

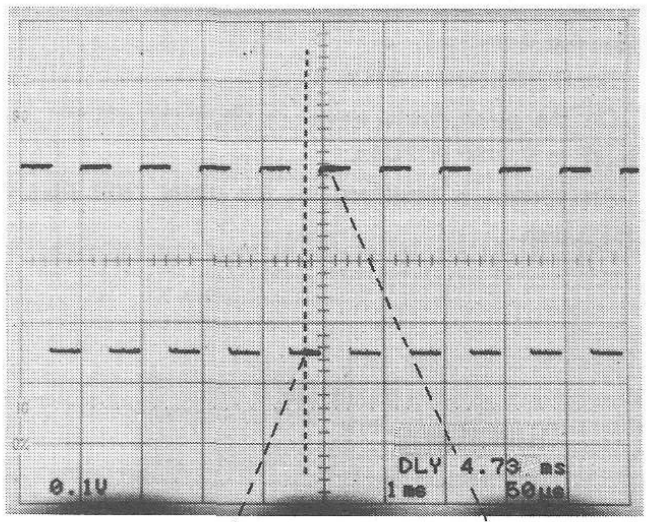
B SWEEP and Data Position

In A INTEN and B DLY'D, a data position is effective to B SWEEP.

In the condition ③ shown on the left page;

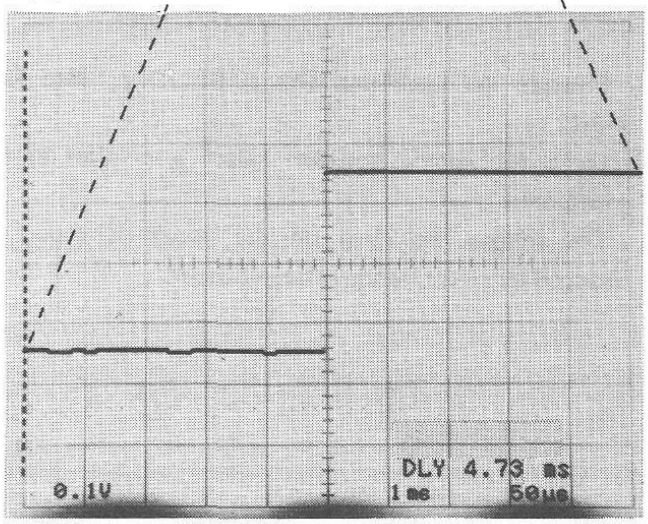
① Pressing ⇩ results in the DATA POSITION mode.

A INTEN



② Set HORIZ DISPLAY to DLY'D.

Data Position 0



4-8-10 DISP SCROLL

The waveform stored (stop status) in the following ranges can be enlarged.

SEC/DIV : Enlargement up to 100 times in a 1-2-5 sequence

Procedure

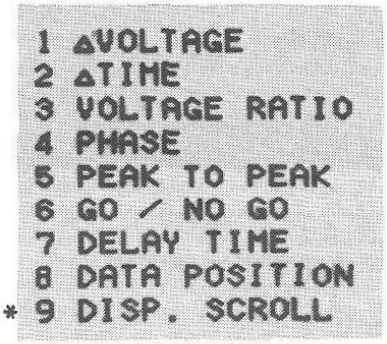
① Set STORAGE to ON.

② Display on the screen the waveform to be enlarged (See Fig. 4-8-12 a.)

③ Set RUN/STOP to STOP (lit off).

④ On the guide menu screen is displayed, set the "*" mark to 9 DISP SCROLL.

An address is displayed on the upper right part of the screen.



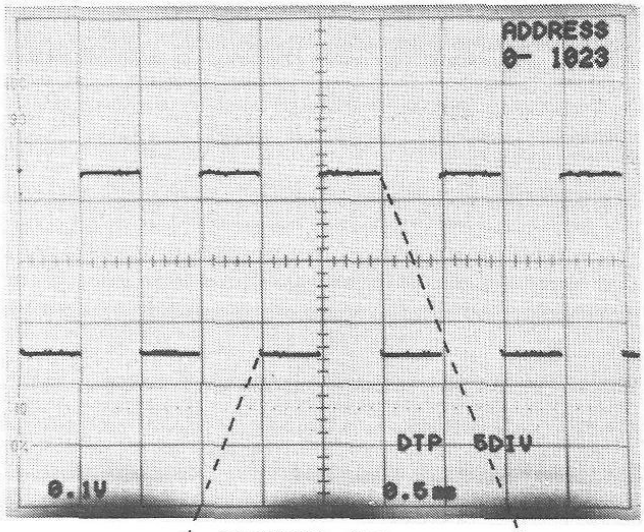
⑤ Enlarges the waveform with A SEC/DIV. (See Fig. 4-8-12 b)

⑥ Using the rotary encoder, select a portion to be measured.

The address displayed on the upper right part is changed by adjusting the rotary encoder.

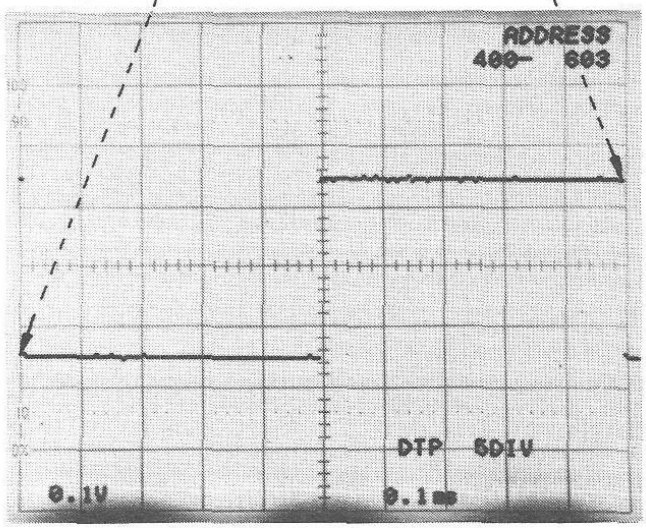
Figure 4-8-12. DISP SCROLL

a. Sotred Waveform



SEC/DIV : 0.5 ms

b. Enlarged Waveform



SEC/DIV : 0.1 ms

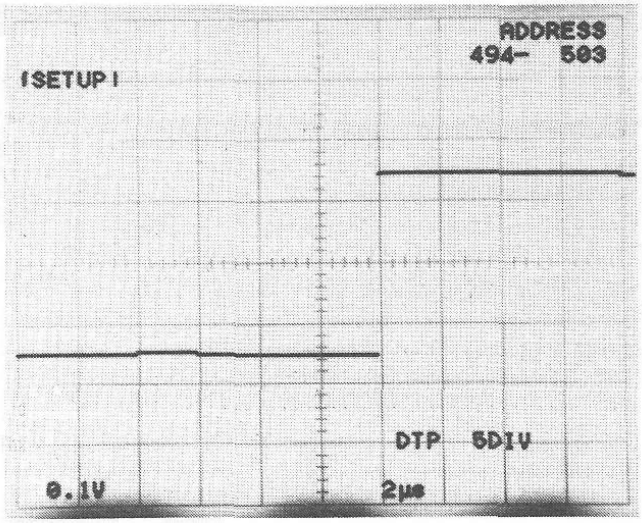
The figure b shows an enlarged view of the protion ranging from address 400 to 603 in the figure above (a).

CAUTION

! SETUP ! Display

If setting is done beyond an enlargement enabled range, "! SETUP !" will be displayed on the screen.

When this appears, numerals on the screen follow a change of setting, but the waveform does not.



MEMO

Section 5 GP-1B Interface(Option)

5-1 General

This instrument allows DS-504 (unit for GP-IB) or DS-505 (unit for RS-232C) to be attached to it.

When DS-504 is attached, an automatic measuring system can be easily configured by connecting to a personal computer, etc. which has the GP-IB interface.

Its electronical and mechanical specifications conform to IEEE Std. 488-1978.

5-1-1 Specifications of GP-IB

I/O signals

Input TTL level Active Low

Output TTL level Active Low

No. of units connected

Up to 15 units are connectable to one system.

Note: The "number of units connected" x 2 m should not exceed 20 m.

Cable length

A total cable length (2 m x number of units connected) should be within 20 m.

CAUTION

This instrument is to be used preferably under conditions which are relatively good electrically and physically.

5-1-2 Construction

This instrument can be connected to an external controller (mini-computer, personal computer, etc.) or a plotter via GP-IB.

5-1-3 Interface Functions

Table 5-1-3 shows the interface functions of this instrument.

Table 5-1-3

Subset	Function	Description
SH1	Source handshake	Complete capability
AH1	Acceptor handshake	Complete capability
T5	Talker	Basic Talker, Serial poll, Talk Only Mode, Unaddress If MLA
TE0	Talker address extension	No capability
L4	Listener	Basic Listener, Unaddress If MTA
LE0	Listener address extension	No capability
SR1	Service request	Complete capability
RL2	Remote local	No local lock out
PP0	Parallel poll	No capability
DC1	Device clear	Complete capability
DT0	Device trigger	No capability
C0	Controller	No capability

5-2 INSTRRUMENT INFORMATION

5-2-1 Address, Delimiter and Talk Only

a. Address and Delimiter

Address refers to the address of this instrument used by the remote function. The address of this instrument is used when a relevant controller specifies this instrument either as Talker or Listener.

The delimiter of this instrument is used to indicate and end of the data string, block or record transferred between a relevant controller and this instrument.

b. TALK ONLY Mode

The TALK ONLY mode is used when outputting a hard copy of the waveform on the screen to the plotter, etc. without using any controller.

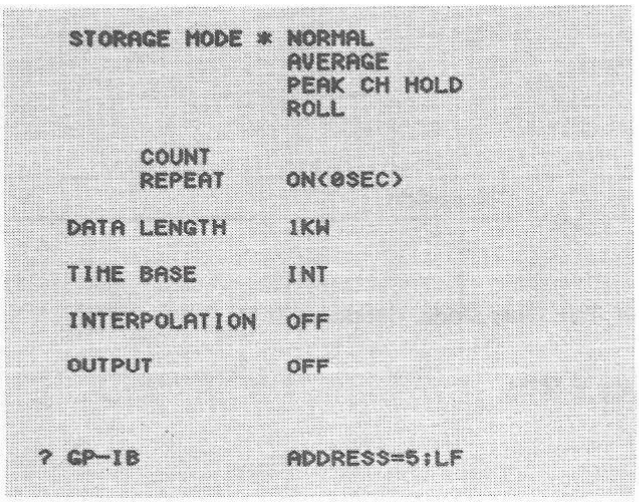
When outputting to the plotter by remote control, send an Output command from the controller to this instrument, and next, specify "Talker".

c. Setting Method

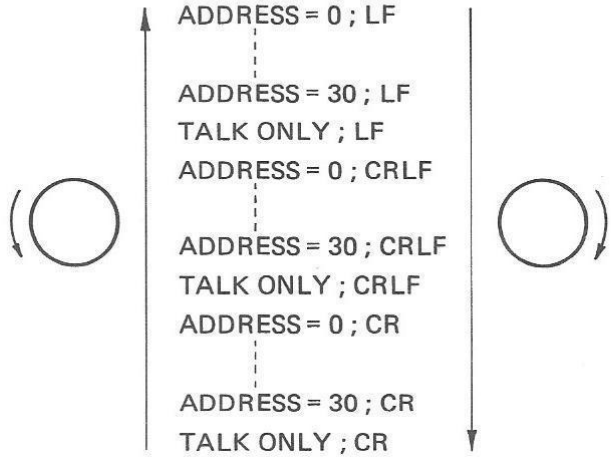
Set the address, delimiter and TALK ONLY mode on the Character screen in the STORAGE mode.

Procedure

① Set the "?" mark to GP-IB.



② Using the rotary encoder, select the address and delimiter.



5-2-2 EOI Message

a. Output : It is output synchronously with the last one of the data to be output.

b. Input : It may be or may not be input.

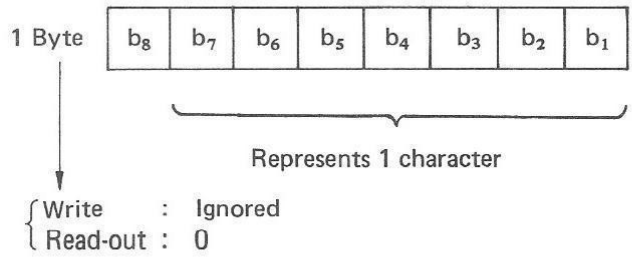
5-3 DATA CODES

The following codes are selectively used in order to represent the contents of data groups, etc. handled in GP-IB command or data transfer:

- ASCII code
- Binary code

a. ASCII Code

Description of IS07 Bit Code

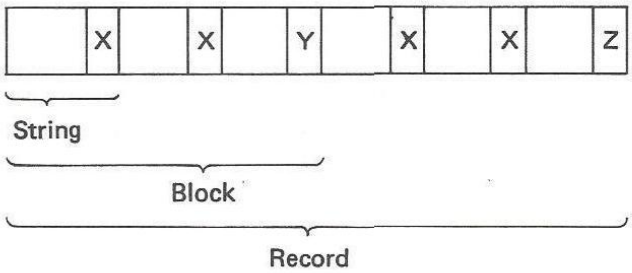


b. Binary Code

Data contents are shown in binary numbers.

5-4 DATA TRANSFER FORMAT

Data transferred on GP-IB consists of components; string, block and record.



X : String delimiter
Y : Block delimiter
Z : Record delimiter

String : Group of a series of data bytes which shows one value

Block : Group of strings which shows the same type

Recrod : Group of block (strings) to be transferred at one time

For this instrument, however, the block and record are equal to each other. To mark off the record, ASCII transfer format uses CR/LF/CRLF, and binary transfer format uses the number of bytes.

5-4-1 Strings by Transfer Type

Data transfer of this instrument includes waveform data input/output, SETUP input/output, auxiliary information output and cursor measured value output.

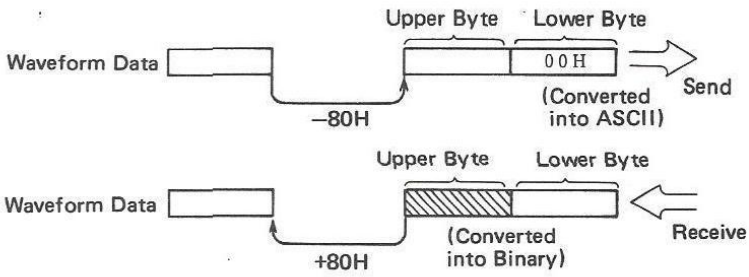
The following describes the strings for each transfer type.

Waveform Data Format

a. ASCII Code Type;

Subtract 80H from waveform data of 1 byte (assume it as signed data) and set its result in the upper byte of a 2-byte area. In the lower byte, set 00H, convert this data into an ASCII code and send it.

In case of receive data, convert it into bianry data, and then, store in a specified file the data (1 byte) with 80H added to the upper 1 byte.



b. Binary Code Type

Subtract 80H from waveform data of 1 byte (assume it as signed data), set its result in the upper byte of a 2-byte area, set 00H in the lower byte and send it.

Table 5-4

Item \ Format	Data Representation	No. of String Bytes	String Mark-off
Waveform data (ASCII)	ASCII code (signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Waveform (binary)	Binary value	2 bytes	2-byte data
SETUP and waveform collateral information	ASCII code (signed integer)	Input: Indefinite Output: Up to 6 bytes	Delimiter
Auxiliary information	Combination of ASCII code	Up to 10 bytes	Delimiter
Cursor measured value	Combination of ASCII code	Up to 11 bytes	Delimiter
Status sense	ASCII code	1 byte	Delimiter

5-4-2 Transfer Format by Transfer Type

The following provides detailed descriptions on transfer formats by transfer type:

a. Input/Output of Waveform Data

- ASCII type transfer

  d_1) d_2) d_3) .....) dn)

  dn : Data (ASCII)

- Binary type transfer

  d_1 d_1' d_2 d_2' ..... dn dn'

  dn dn' : Data (2 bytes/1W)

  dn' (lower byte) is always "0".

b. Input/Output of SETUP and Waveform Collateral Information

d_1) d_2) d_3) ..... dn

dn : Data (ASCII)

c. Output of Auxiliary Information

c_1) d_1) c_2) d_2) ..... c_6) d_6)

c_1 : Identification code
d_1 : Data
} ASCII code

d. Output of Cursor Measured Value

e) d_1) d_2) d_3) ..... dn)

e : No. of data
dn : Data
} ASCII code

e. Output of Status Sense

d_1) d_2) d_3

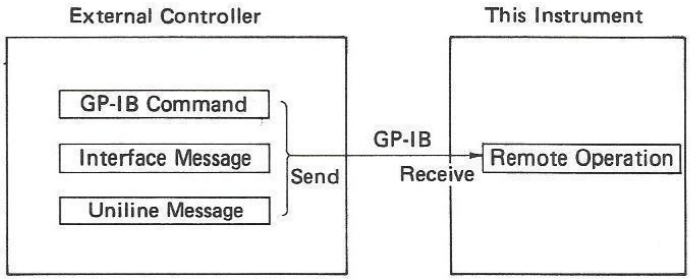
d_1 : RUN status
d_2 : GO/NO GO judgment
d_3 : Waveform input status
} ASCII code

5-5 REMOTE OPERATIONAL FUNCTIONS

5-5-1 General

This instrument can be remotely operated from the external controller via GP-IB.

Remote operation is done based on a combination of GP-IB command, interface message and uniline message (IFC, REN, ATN).



Remote operational functions are classified into the following detailed functions:

- Panel operation
- Data transfer
- Status output
- Control message response

5-5-2 Panel Operation

Part of panel operation of this instrument can be done with GP-IB commands from the external controller.

The following shows details of panel operation which can be remotely controlled:

- REAL
- STORAGE
  - STORAGE MODE { NORM / AVERAGE / PEAK CH HOLD / ROLL }
  - DATA LENGTH
  - TIME BASE
  - INTERPOLATION
  - OUTPUT
- STORE REF
- RUN/STOP
- CURSORS & DELAY { ΔVOLTAGE / ΔTIME / VOLTAGE RATIO / PHASE / PEAK TO PEAK / GO/NO GO / DELAY TIME / DATA POSITION / DISP. SCROLL }
- V MODE
- HORIZ DISPLAY
- A SEC/DIV
- B SEC/DIV
- SWEEP MODE
- SINGLE RESET
- A TRIGGER SOURCE
- B TRIGGER SOURCE
- TRIGGER COUPLING
- TRIGGER SLOPE

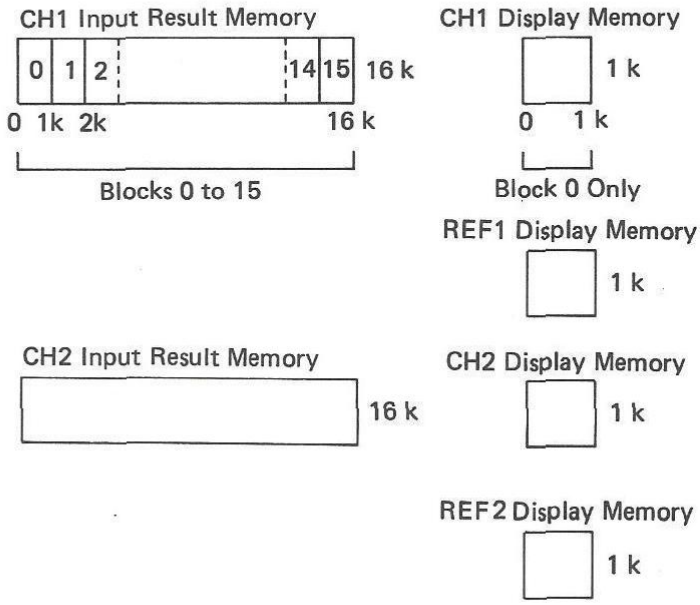
5-5-3 Data Transfer

This instrument provides input/output of waveform data, SETUP data and waveform collateral information, and output of auxiliary information, cursor measured value and status sense.

a. Reading out and Writing the Waveform Data

Reading-out and writing of waveform data are available for each of input result memories (CH1, CH2,) and each of display memories (CH1, CH2, REF1, REF2). Either ASCII or binary transfer is selectable.

For the number of transfer data (data length), you can select one of 1 k, 2 k, 4 k, 8 k and 16 k and specify a transfer block by the unit of 1 k.



b. Reading out and Writing the SETUP Data

You can Collectively perform setting and reading-out as to remotely controllable panel keys.

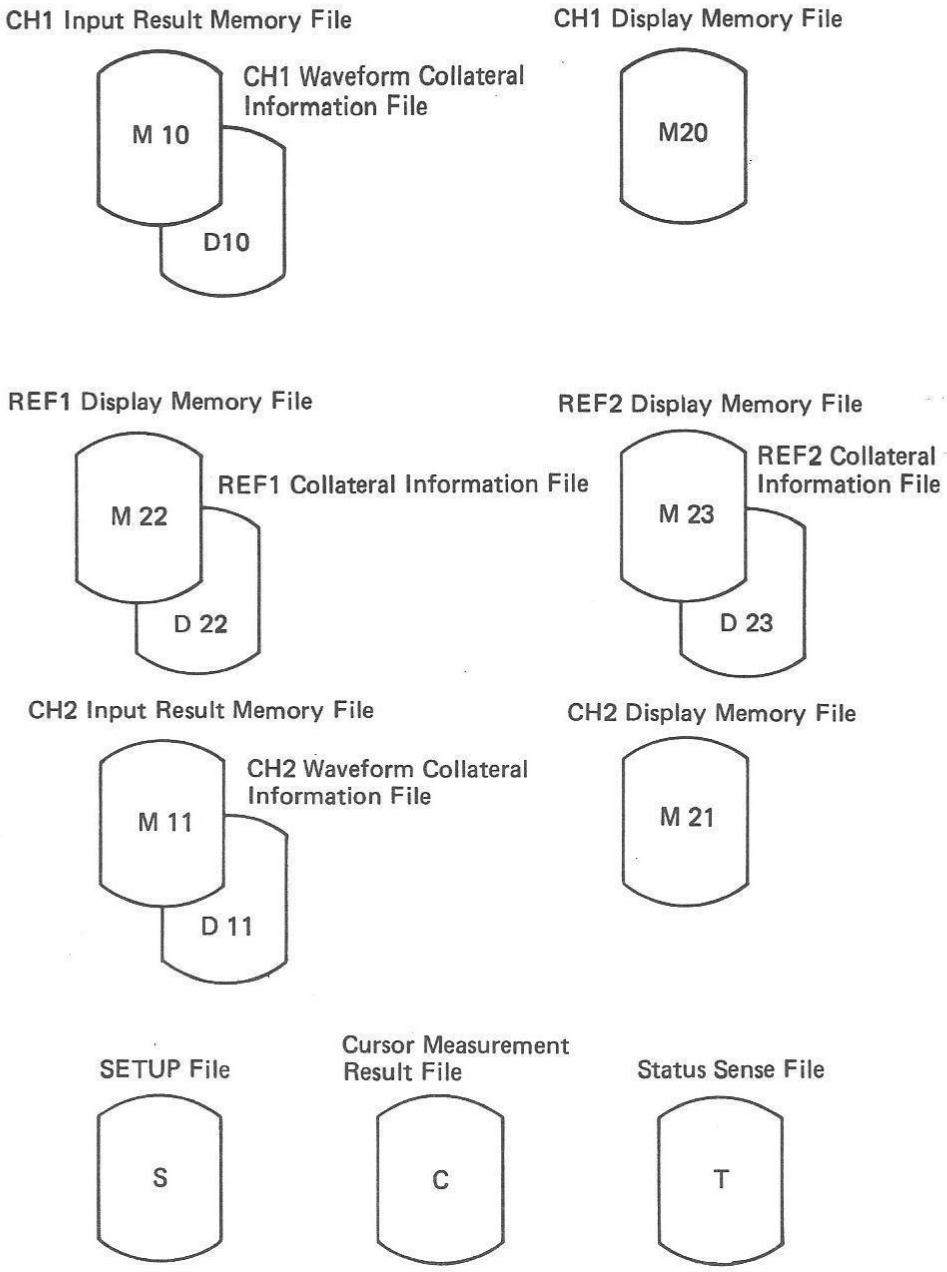
For the details, refer to the appendix at the end of this manual.

c. Reading out and Writing the Waveform Collateral Information

To the memory which allows waveform data to be read out and written, its collateral information can be read out and written. (Collateral information related to the CH1 and CH2 display memories are impossible.)

For the details, refer to the appendix at the end of this manual.

[Note 1] The following describes the files handled by IX and JX commands.



[Note 2] The input result waveform entered in the ROLL mode is stored in the input buffer (data length always 1 kW). When it is input in the AVERAGE or PEAK CH HOLD mode, an input result of data length is 1 kW, even if its data length input is 16 kW.
Waveform collateral information indicates a length of 16 kW in this case.

d. Sending the Auxiliary Information

Of specified auxiliary information, this instrument output the following items only. (ASCII code)

- No. of data
- No. of binary data
- Data length (No. of data sent in an ASCII type format)
- ΔX (resolution per data)
- Y-FULL SCALE (physical amount value converted from the maximum value which the waveform data can assume)
- No. of DELAY WORDs
- ZERO value

Basic Transfer Sequence and Format (Example)

1. No. of data	AA ⤶ 7 ⤶
2. No. of binary data	AB ⤶ 2 ⤶
3. Data length	AC ⤶ 16384 ⤶
4. ΔX	AD ⤶ 2.0E–03 ⤶
5. Y-FULL SCALE	AE ⤶ 1.024E + 02 ⤶
6. No. of DELAY WORDs	AF ⤶ –16000 ⤶
7. ZERO value	AG ⤶ –32768 ⤶

↓
(Identication code
(delimiter)

ΔX is obtained as follows:

Assume that a sweep time (SEC/DIV) for the waveform displayed on the screen is T_1, and that a sweep time (SEC/DIV) when capturing the waveform is T_0. T_0 is normally equal to T_1. In the modes other than the ROLL mode, however, it is 10 μs/div when high-speed sweep at 10 μs/div or faster is applied. In the ROLL mode, it is 0.1 ms/div when high-speed sweep at 0.1 ms/div or faster.

From the above, ΔX upon input of the waveform is calculated as follows:

$$\Delta X = \frac{T_0}{100}$$ (except for ROLL mode)

$$\Delta X = \frac{1000 \times T_0}{100}$$ (ROLL mode)

Next, consider the case when the STOP mode is selected after inputting the waveform and panel setting is updated. Assuming that a panel set value after updating (SEC/DIV) is T_2, that the panel set value when maximumly enlarged is T_3, and that the panel set value when minimumly reduced is T_4, ΔX in waveform editing is calculated as follows:

$$\Delta X = \frac{T_0}{100}$$ (Enlargement with interpolation turned off)

$$\Delta X = \frac{5 \times T_2}{100}$$ (Enlargement with interpolation turned on: $T_2 \geq T_3$)

$$\Delta X = \frac{5 \times T_3}{100}$$ (Enlargement with interpolation turned on: $T_2 < T_3$)

$$\Delta X = \frac{T_2}{100}$$ (Reduction: $T_2 \leq T_4$)

$$\Delta X = \frac{T_4}{100}$$ (Reduction: $T_2 > T_4$)

[Note] The waveform displayed also multiplies a SEC/DIV value by 1,000 times, if it is the ROLL mode.

Y-FULL SCALE, DELAY WORD value and ZERO value are calculated as follows:

$$\text{Y-FULL SCALE} = \frac{256 \times \text{VOLTS/DIV Value at Waveform Data Input Time}}{25}$$

DELAY WORD (for length of 1 kW) = DATA POSITION x (–100)

DELAY WORD (for length of 16 kW) = DATA POSITION x (–100) x 16

ZERO value = GND level value

e. Reading out the Cursor Measured Value

A type of cursor measurement currently under way and measured values are output in terms of ASCII code with units.

Output data are as follows:

- ΔVOLTAGE : CH1 voltage value, CH2 Voltage value
- ΔTIME : Time value, frequency
- VOLTAGE RATIO : Voltage ratio (%), voltage ratio (dB)
- PHASE : Phase (°)
- PEAK TO PEAK : CH1 P-P value, CH2 P-P value

(Example) for ΔTIME

2 1.00E−03 1.00E + 03

[Note 1] Data distinguished CH1 and CH2 are output by V-MODE.
CH2V is output in the X-Y mode of ΔVOLTAGE, and CH1 V is output in the X-Y mode of ΔTIME.

[Note 2] When an output result is ∞, "INFINITY" is output.
The following marks may be added:
VARIABLE mark : "<" or ">"
Saturation mark : "<=" or ">="

f. Outputting the Status Sense

Current status sense, such as waveform writing under way or writing end, is output in terms of ASCII code.

Output values have the following meanings:

- RUN status
  - 0 : Non-RUN status
  - 1 : RUN status
- GO/NO GO judgment
  - 0 : GO (non-operating)
  - 1 : NO GO
- Waveform input status
  - 0 : Waveform input end
  - 1 : Waveform input under way

(Example) When waveform writing ends while GO/NO GO is operating: (judged as NO GO)

0 1

5-5-4 Status Output

This function informs the external controller of internal operating condition of an instrument, such as error generation, completion of operation, etc. using an SRQ signal and a status byte.

a. SRQ Generation Factors

SRQ generation factors are mainly classified into two cases; when an error takes place and when operation normally terminates.

When an error takes place:

- When an undefined command is received
- GP-IB command parameter error
- When the GP-IB command cannot be executed
- Excessive word length of the GP-IB command

When operation normally terminates:

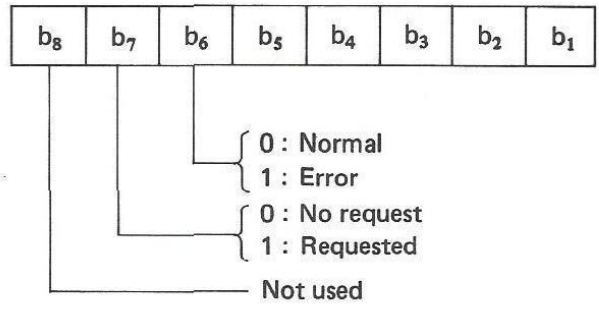
- Completion of storage waveform fetching (completion of AVERAGE and PEAK CH HOLD)
- GO/NO GO judgment result
- Output termination

b. Status Byte

The contents of the SRQ generation factors mentioned in "a. SRQ Generation Factors" can be known by making the external controller read out the status byte with a serial poll sequence.

The following describes the status byte:

- Status byte



b_8	b_7	b_6	b_5	b_4	b_3	b_2	b_1	Description
0	1	1	0	0	0	0	1	Excessive word length of the GP-IB command
0	1	1	0	0	1	0	0	GP-IB command not executable
0	1	1	0	1	0	0	0	GP-IB command parameter error
0	1	1	1	0	0	0	0	Underfined command received
0	1	0	0	1	0	0	0	Waveform fetching completed AVERAGE/PEAK CH HOLD completed
0	1	0	0	0	1	0	0	Output end
0	1	0	0	0	0	1	0	GO/NO GO: NO GO
0	1	0	0	0	0	0	1	GO/NO GO: GO

c. Clearing the SRQ Signal and Status Byte

- When the serial poll sequence is conducted
- When DCL or SDC is received

5-5-5 Control Message Responses

The following describes control message responses:

Message	Description of Response from the Instrument
IFC	Initializes the interface and makes the Listener and Talker functions idle.
REN	Remote operation is enabled when MLA is also sent.
ATN	Receives the data on the bus as an interface messages and responds to it.
EOI	Used as a delimiter for data transfer record.
DCL, SDC	Unitializes the instrument, interrupts operation and clears SRQ.
SPE, SPD	Performs serial poll operation and sends the status byte.
UNL	Clears the LISTENER mode and interrupts data transfer. Operation can be resumed if the LISTENER mode is specified again.
UNT	Clears the TALKER mode and interrupts data transfer. Operation can be resumed if the TALKE mode is specified again.
MLA	If a current mode is TALKER, it is cleared and switched to the LISTENER mode. Data transfer is forcibly terminated if it is under way.
MTA	If a current mode is LISTENER, it is cleared and switched to the TALKER mode. Data receiving is forcibly terminated if it is under way.
DAV, NRFD NDAC	Data is transferred by 3-wire handshaking.
GTL	The same operation is done as when the LOCAL key on the panel is pressed. Unlocks the panel key and the system is under local control.
LLO	No response

[Note 1] LOCAL mode

When a GTL message is received or the LOCAL key on the panel is pressed after terminating remote control, the instrument enters the REAL mode and other settings assume those provided by the panel. (same as when the power is turned on)

[Note 2] Device Clear

After receiving Device Clear (DCL, SDC), the instrument stops handshaking and performs processing for Device Clear (same as processing provided by the STOP key). Handshaking is cleared after terminating Device Clear processing.

5-6 BUS LINE CONFIGURATION

a. Data Bus (DIO 1 to 8)

8 bidirectional bus lines for transferring multiline messages in a bit parallel and byte serial manner.

b. Handshake Bus (DAV, NRFD, NDAC)

Provides 3-wire handshaking in order to securely transfer multiline messages on the data bus.

- DAV (Data Valid)
  Indicates that the data on the bus is valid.
- NRFD (Not Ready For Data)
  Indicates whether the system is ready for receiving data.
- NDA (Not Data Accepted)
  Indicates whether data receiving is completed.

c. Management Bus (ATN, IFC, REN, SRQ, EOI)

- ATN (Attention)
  This is a signal output by a relevant controller.
  The state that ATN is True (Low level on the bus line because GP-IB is of negative logic) is called the COMMAND mode. When ATN is False (High on the bus line), it is called the DATA mode.
  In the COMMAND mode, the controller transfers a message to all devices on the buses. All messages sent by the controller in the COMMAND mode are provided by standards.
  In the DATA mode, data is transferred to either Talker or Listener.
- IFC (Interface Clear)
  This signal is output by the system controller and used for resetting the interface system.
  When the IFC signal is received, the Talker and Listener functions of the instrument are made idle.
  However, it does not affect the contents of a service request and the status byte.
- REN (Remote Enable)
  This signal is output by the system controller and used for switching remote control/local control of the device. The device specified as Listener with REN being True status assumes remote control.
  If REN is set to False, all devices on the buses will be put in a local control state.
- SRQ (Service Request)
  This is output when the device on the bus requests the controller for a service (one of measurement end, search error occurrence and program error).
- EOI (End Or Identify)
  In the DATA mode, this is used as an END message. The Talker outputs it to indicate the last byte when transmitting data of multiple bytes.
  In the COMMAND mode, it is output from a relevant controller as an IDENTIFY message.

Table 5-6 Bus Lines and Connector Pins

Pin No.	Bus Line	Purpose of Use
1	DIO 1	(LSB)
2	DIO 2	Data bus
3	DIO 3	
4	DIO 4	
5	EOI	Management bus
6	DAV	Handshake bus
7	NRFD	
8	NDAC	
9	IFC	Management bus
10	SRQ	
11	ATN	
12	GND	Grounding
13	DIO 5	Data bus
14	DIO 6	
15	DIO 7	
16	DIO 8	
17	REN	Management bus
18	GND	Grounding
〈	〈	
24	GND	

Figure 5-6-1. Interface Functions and Bus Lines

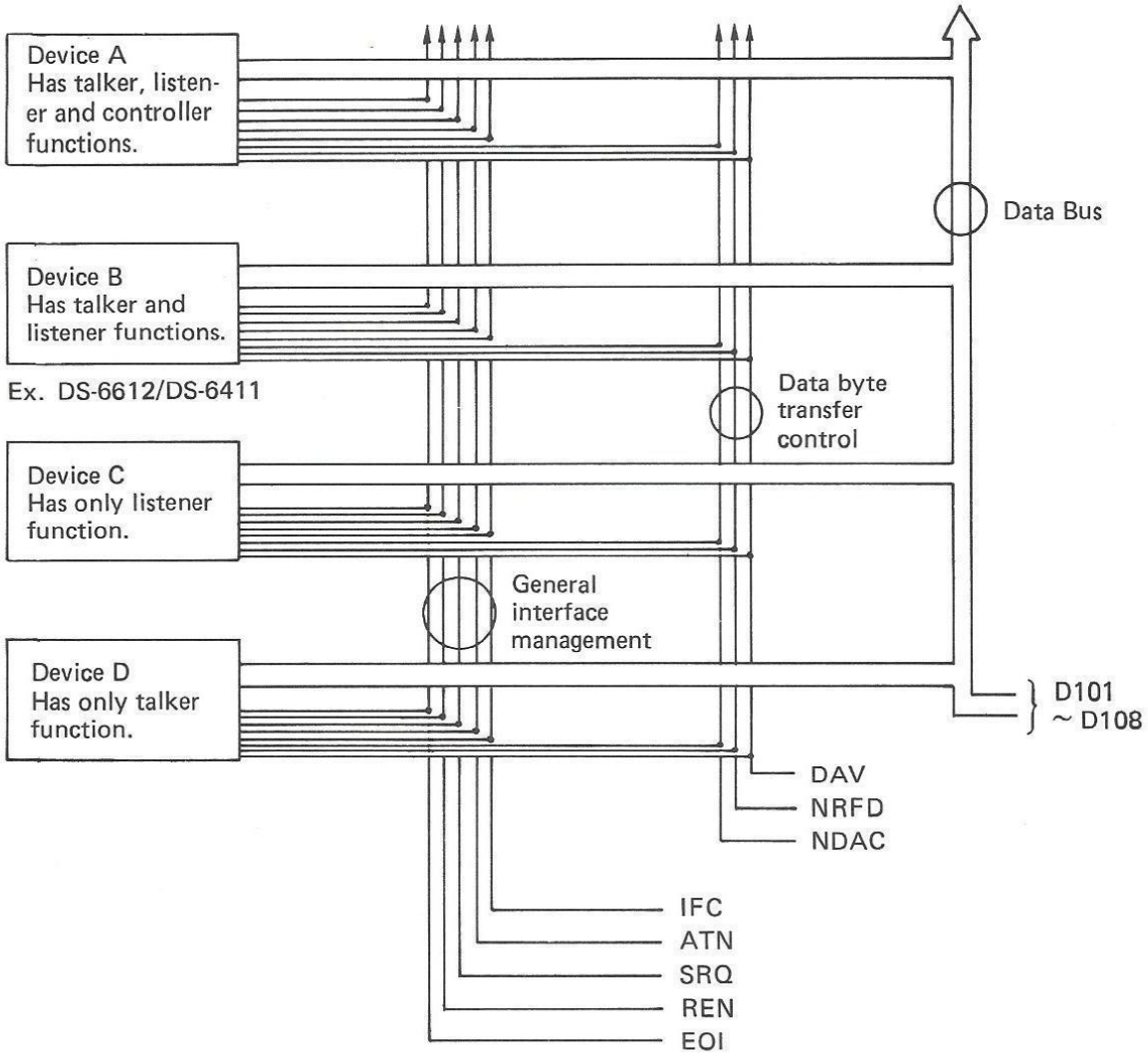
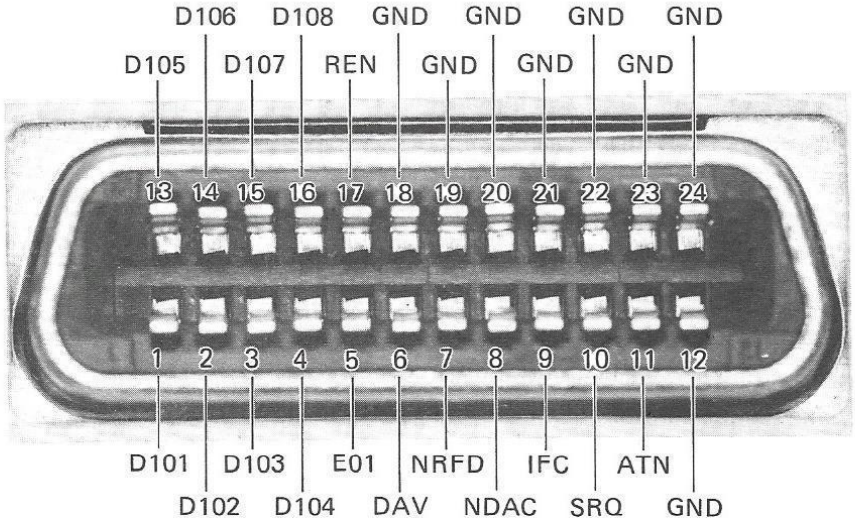


Figure 5-6-2. Bus Lines and Connector Pins



Section 6 Specific Equipment Commands

6-1 GP-IB COMMANDS

GP-IB commands are remote operation control commands to the instrument and sent from the external controller via GP-IB.

The GP-IB commands are classified into the following categories:

- Remote operation commands
- Data transfer commands

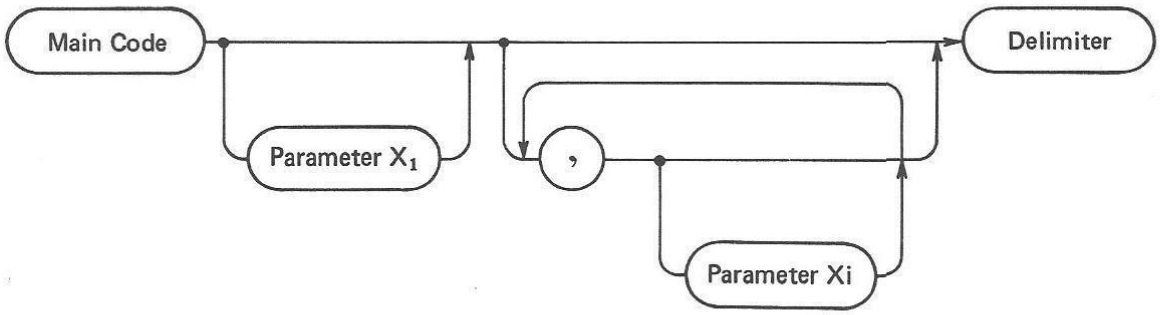
As a common matter, however, no multistatement is allowed.

Format

The following describes the code and format for the GP-IB commands.

(1) Input code
ISO 7-bit code

(2) Format



Example. ATD 13

Main code: Code which indicates a control item.
Consists of a combination of 2 or 3 alphanumerals.

Parameter: Indicates details of a function specified by the main code. Sets a numerical value/character string. Space between the main code and parameter.

" , " : Parameter marking-off symbol used when multiple parameters are used.

Delimiter : Indicates an end of one statement.

6-2 COMMAND TYPES

(1) Measurement Parameters

a VERT MODE
b HORIZ DISPLAY
c A SEC/DIV
d B SEC/DIV
e SWEEP MODE
f SINGLE RESET
g A TRIGGER SOURCE
h B TRIGGER SOURCE
i TRIGGER COUPLING
j TRIGGER SLOPE

(2) Operation Modes

a REAL/STORAGE/AVERAGE/PEAK CH HOLD/ ROLL
b DATA LENGTH
c INTERPOLATION
d TIME BASE
e OUTPUT
f RUN/STOP
g STORE REF

(3) CURSORS & DELAY

a MEASUREMENT BY CURSORS (GO/NO GO included)
b DELAY TIME
c DATA POSITION
d DISP SCROLL
e CURSOR

(4) Others

a SRQ (SRQ mask control)
b DMA (DMA selection)

(5) Data Transfer Commands

a Waveform data input
b Waveform data output
c SETUP input
d SETUP output
e Auxiliary information output
f Cursor measured value output
g Status sense output
h Collateral information input on waveform
i Collateral information output on waveform

Table 6-2 Remote Operation Commands List

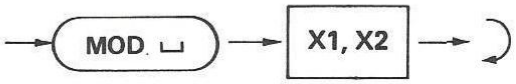
Item No.	Format	Description
1	MOD ␣ [X1, X2]	VERT MODE (Only Storage Valid)
2	HDS ␣ [X]	HORIZ DISPLAY
3	ATD ␣ [X]	A SEC/DIV
4	BTD ␣ [X]	B SEC/DIV
5	OPM ␣ [X]	SWEEP MODE
6	RST	SINGLE RESET
7	TAS ␣ [X]	A TRIGGER SOURCE
8	TBS ␣ [X]	B TRIGGER SOURCE
9	TAC ␣ [X]	TRIGGER COUPLING
10	ATP ␣ [X]	TRIGGER SLOPE
11	MES ␣ [X1, X2, X3]	REAL/STOREGE (NORMAL, AVERAGE, PEAK CH HOLD, ROLL)
12	DTL ␣ [X]	DATA LENGTH
13	IPL ␣ [X]	INTERPOLATION
14	TMB ␣ [X]	TIME BASE
15	OTP ␣ [X1, X2]	OUTPUT
16	RUN ␣ [X]	RUN/STOP
17	REF	STORE REFRENCE
18	CUR ␣ [X1, X2, X3, X4, X5]	Cursor measurement
19	DTM ␣ [X]	DELAY TIME
20	DTP ␣ [X]	DATA POSITION
21	DAD ␣ [X]	DISP SCROLL
22	SRQ ␣ [X1, X2]	SRQ mask
23	DMA ␣ [X1, X2]	DMA selection
24	IX ␣ [X1, X2, X3, X4]	Receive command
25	JX ␣ [X1, X2, X3, X4]	Send command

6-3 DETAILS OF COMMANDS

6-3-1 Remote Operation Commands

(1) VERT MODE

Format



Parameters

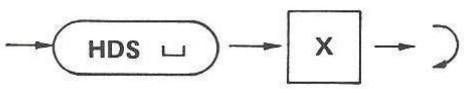
X1	VERT MODE
1	CH1
2	CH2
3	ADD *1
4	DUAL
5	TRI *1
6	X-Y

*1 Results in a status error in the STORAGE mode.

X2	ALT (REF OFF)/CHOP (REF ON)
0	ALT (REF OFF)
1	CHOP (REF ON)

(2) HORIZ DISPLAY

Format

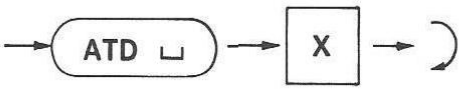


Parameters

X	HORIZ DISPLAY
1	A
2	A INTEN
3	B
4	ALT (REAL only. Underfined in the STORAGE mode)

(3) A SEC/DIV

Format



Parameters

X	A SEC/DIV	
	Non-ROLL Mode	ROLL Mode
1	0.5 sec	500 sec
2	0.2 sec	200 sec
3	0.1 sec	100 sec
4	50 msec	50 sec
5	20 msec	20 sec
6	10 msec	10 sec
7	5 msec	5 sec
8	2 msec	2 sec
9	1 msec	1 sec
10	0.5 msec	0.5 sec
11	0.2 msec	0.2 sec
12	0.1 msec	0.1 sec
13	50 μsec	0.1 sec
14	20 μsec	0.1 sec
15	10 μsec	0.1 sec
16	5 μsec	0.1 sec
17	2 μsec	0.1 sec
18	1 μsec	0.1 sec
19	0.5 μsec	0.1 sec
20	0.2 μsec	0.1 sec
21	0.1 μsec	0.1 sec

(4) B SEC/DIV

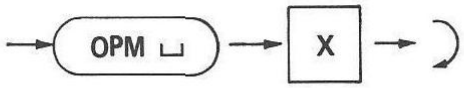
Format

Parameters

X	B SEC/DIV	
	Non-ROLL Mode	ROLL Mode
4	50 msec	50 sec
5	20 msec	20 sec
6	10 msec	10 sec
7	5 msec	5 sec
8	2 msec	2 sec
9	1 msec	1 sec
10	0.5 msec	0.5 sec
11	0.2 msec	0.2 sec
12	0.1 msec	0.1 sec
13	50 μsec	0.1 sec
14	20 μsec	0.1 sec
15	10 μsec	0.1 sec
16	5 μsec	0.1 sec
17	2 μsec	0.1 sec
18	1 μsec	0.1 sec
19	0.5 μsec	0.1 sec
20	0.2 μsec	0.1 sec
21	0.1 μsec	0.1 sec

(5) SWEEP MODE

Format



Parameters

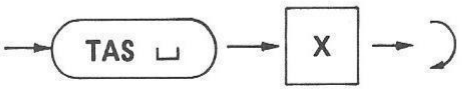
X	SWEEP MODE
1	AUTO
2	NORM
3	SINGLE

(6) SINGLE RESET

Format

(7) A TRIGGER SOURCE

Format



Parameters

X	A TRIGGER SOURCE
1	CH1
2	CH2
3	CH3
4	LINE

(8) B TRIGGER SOURCE

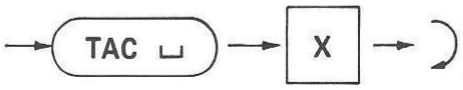
Format

Parameters

X	B TRIGGER SOURCE
0	RUNS AFTER DELAY
1	TRIG'D

(9) TRIGGER COUPLING

Format



Parameters

X	TRIGGER COUPLING
1	AC
2	DC
3	HF REJ
4	TV

(10) TRIGGER SLOPE

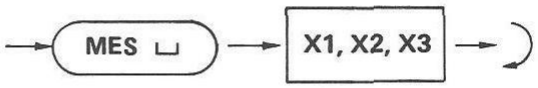
Format

Parameters

X	TRIGGER SLOPE
0	+
1	–

(11) REAL/STORAGE (NORMAL, AVERAGE, PEAK CH HOLD, ROLL)

Format



Parameters

X1	MODE
0	REAL
1	NORMAL (STORAGE)
2	AVERAGE (STORAGE)
3	PEAK CH HOLD (STORAGE)
4	ROLL (STORAGE)

X2	COUNT (Specified Times) *1
1	2 times
2	4 times
3	8 times
4	16 times
5	32 times
6	64 times
7	128 times
8	256 times
–1	∞

*1 Setting disabled in AVERAGE.

X2 or X3	REPEAT ON/OFF *1
0	OFF
1	ON (0 SEC)
2	ON (1 SEC)
3	ON (2 SEC)

*1 The following describes how to specify X2 and X3:

X1	X2	X3
REAL	–	–
NORMAL	REPEAT	–
AVERAGE	COUNT (1 to 8)	REPEAT
PEAK CH HOLD (except ∞)	COUNT (1 to 8)	REPEAT
PEAK CH HOLD (∞)	COUNT (–1)	–
ROLL	–	–

[Note] "–" denotes impossible to set.

(12) DATA LENGTH

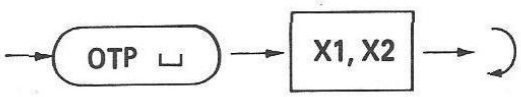
Format

Parameters

X	DATA LENGTH
0	1 k word
1	16 k words

(13) INTERPOLATION

Format

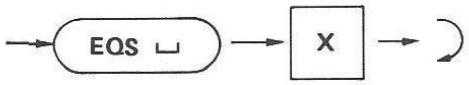


Parameters

X	INTERPOLATION
0	OFF
1	LINEAR
2	SINE

(14) TIME BASE

Format

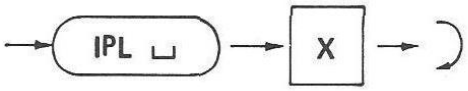


Parameters

X	TIME BASE
0	INT
1	EXT

(15) OUTPUT

Format



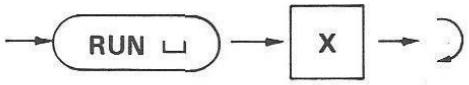
Parameters

X1	Device Type	X2	Output Type
0	OFF	–	
1	PEN	0	CAL
		1	SCALE
		2	WAVEFORM
		3	SCALE + WAVEFORM
2	PLOT	–	

[Note] "–" denotes impossible to set.

(16) RUN/STOP

Format



Parameters

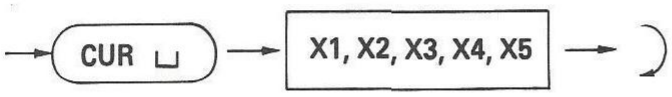
X	RUN/STOP
0	STOP
1	RUN

(17) STORE REF

Format

(18) CURSOR MEASUREMENT

Format



Paramenters

X1	Measurement Item
0	OFF
1	ΔVOLTAGE
2	ΔTIME
3	VOLTAGE RATIO
4	PHASE
6	PEAK TO PEAK
8	GO/NO GO

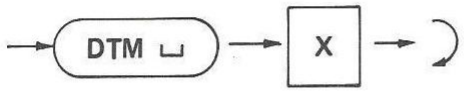
X2 to X5: Cursor setting

Measurement Item	Cursor setting			
	X2	X3	X4	X5
OFF	—	—	—	—
ΔVOLT	H1 cursor	H2 cursor	—	—
ΔTIME	V1 cursor	V2 cursor	—	—
VOLTAGE RATIO	H1 cursor	H2 cursor	REF H1 cursor	REF H2 cursor
PHASE	V1 cursor	V2 cursor	REF V1 cursor	REF V2 cursor
PEAK TO PEAK	V1 cursor	V2 cursor	—	—
GO/NO GO	V1 cursor	V2 cursor	REF waveform width	—

[Note] H cursor : −2048 to 2047
V cursor : 0 to 4095
REF Wave from width : 0 to 255
— : Impossible to set

(19) DELAY TIME

Format



Parameters

X : 0 to 4095
Can be set by every 0.0025 div between 0.2 and 10.4375 div.

(20) DATA POSITION

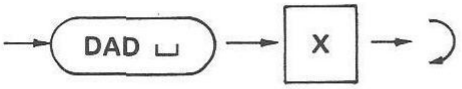
Format

Parameters

X	DATA POSITION
0	0 div
1	1 div
2	2 div
3	3 div
4	4 div
5	5 div
6	6 div
7	7 div
8	8 div
9	9 div
10	10 div

(21) DISP SCROLL

Format

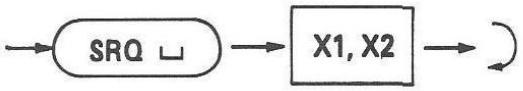


Parameters

X : 0 to 16383
Indicates a display address. When a parameter indicates an odd-number address, it is internally adjusted to an even number.
[Example] 1 → 0
15 → 14

(22) SRQ MASK

Format



Parameters

X1	MASK ON/OFF
0	OFF
1	ON

X2 : Value to be masked (decimal number).
See 5-5-4 "Status Output" in Section 5.

[Note] All are allowed (MASK OFF) when the power is turned on.

(23) DMA Selection

Format

Parameters

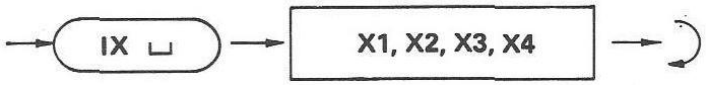
X	DMA Selection
0	DMA not used
1	DMA used

6-3-2 Data Transfer Commands

(24) RECEIVE COMMANDS

a. Waveform Data Writing Command

Format



Parameters

X1	Transfer Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M22	REF1
M23	REF2

X2	Data Transfer Type
1	ASCII
3	BINARY

X3	Data Size Written into File
1	1 k word
2	2 k words
4	4 k words
8	8 k words
16	16 k words

X4 : Transfer start block
0 to 15 (by 1 k word)

CAUTION

When high-speed data memory is used, M10 or M11 cannot be set. Also, in the RUN mode, writing is disabled.

b. SETUP Writing Command

This command rewrites all panel key information managed by software. When information impossible to set is received, no relevant panel key processing is done.

Format

Setting Order of SETUP Receive Data

When SETUP data is received from GP-IB, each function is executed in the following order:

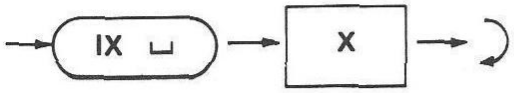
1. V-MODE
2. STORAGE MODE
3. REAL/STORAGE
4. TIME BASE
5. DATA LENGTH
6. INTERPOLATION
7. OUTPUT
8. CURSOR MEASUREMENT

ΔVOLTAGE ΔTIME VOLTAGE RATIO PHASE PEAK TO PEAK GO/NO GO	Sequentially viewing from the top, one turned on first is executed.
DELAY TIME DATA POSITION DISP SCROLL	When all are turned off, execution ends.

9. DELAY TIME (hard setting only)
10. TRIGGER SOURCE
    TRIGGER COUPLING
    TRIGGER SLOPE
    SWEEP MODE
    HORIZ AFTER/TRIG'D
    A SEC/DIV
    B SEC/DIV

c. *Collateral Information Writing Command on Waveform*

Format



Parameters

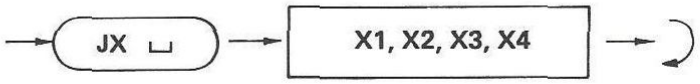
X	Collateral Information File on waveform
D10	CH1 INPUT
D11	CH2 INPUT
D22	REF1
D23	REF2

[Note] The number of data of collateral information on waveforms depend on the files.

(25) SEND COMMANDS

a. Waveform Data Read-out Command

Format



Parameters

X1	Transfer Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M20	CH1 DISP
M21	CH2 DISP
M22	REF1
M23	REF2

X2	Data Transfer Type
1	ASCII
3	Binary

X3	Data Length Read from File
1	1 k word
2	2 k words
4	4 k words
8	8 k words
16	16 k words

X4 : Transfer start block
0 to 15 (by 1 k word)

CAUTION

When the waveform is fetched in the AVERAGE or PEAK CH HOLD mode or with a data length of 1 k word, a data length for M10 or M11 is 1 k word.

b. SETUP Read-out Command

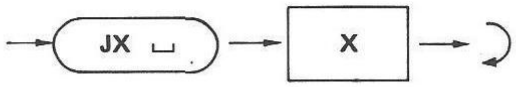
Of panel key information currently set, this command reads out all of it managed by software.

Format

[Note] The number of data in the SETUP file differs between writing and reading-out.

c. Collateral Information Read-out Command on Waveform

Format

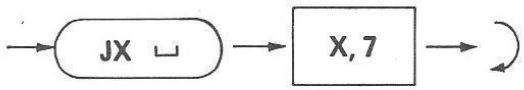


Parameters

X	Collateral Information File on Waveform
D10	CH1 INPUT
D11	CH2 INPUT
D22	REF1
D23	REF2

d. Auxiliary Information Read-out Command

Format



Parameters

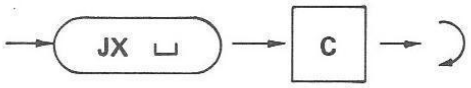
X	Input Result Memory File
M10	CH1 INPUT
M11	CH2 INPUT
M20	CH1 DISP
M21	CH2 DISP
M22	REF1
M23	REF2

[Note] A value 7 in the format means a combination of ASCII data (integer, real number, floating decimal point, alphanumeral, etc.).

e. Cursor Measured Value Read-out Command

This command sends a value of cursor measurement currently under way.

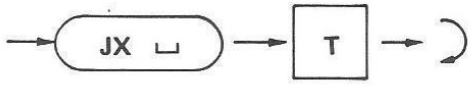
Format



f. Status Sense Output

This command outputs the current RUN mode and a GO/NO GO judgment result.

Format



MEMO

6-4 SAMPLE PROGRAM

6-4-1 PC-9801

Waveforms taken in by DS-6411 are transferred to the controller and displayed.

```
10 '********** DS-6612/DS6411 GP-IB TEST PROGRAM ***********
20 '
30 ISET IFC
40 ISET REN
50 DM=30                    'DS6411  : GP-IB ADDR=30
60 S=0
70 CMD DELIM=0
80 SRQ OFF
90 ON SRQ GOSUB *INTR
100 SRQ ON
110 WBYTE &H14;             'DEVICE CLEAR
120 CLS 3
130 DIM BUFFER1(1023)
140 DIM BUFFER2(1023)
150 '********* SET SETUP ***********"
160 PRINT@ DM;"RUN 0"       'RUN/STOP          STOP
170 PRINT@ DM;"MOD 4,0"     'V MODE            DUAL,REF OFF
180 PRINT@ DM;"HDS 1"       'H DISPLAY         A
190 PRINT@ DM;"ATD 14"      'A TIME/DIV        20USEC/DIV
200 PRINT@ DM;"TAS 1"       'A TRIG.SOURCE     CH1
210 PRINT@ DM;"TAC 1"       'TRIG. COUPLING    AC
220 PRINT@ DM;"ATP 0"       'TRIG. SLOPE       +
230 PRINT@ DM;"MES 1,1"     'STORAGE MODE      NORMAL,COUNT 2
240 PRINT@ DM;"DTL 0"       'DATA LENGTH       1K WORD
250 PRINT@ DM;"IPL 0"       'INTERPOLATION     OFF
260 PRINT@ DM;"TMB 0"       'TIME BASE         INT
270 PRINT@ DM;"DSP 0,0"     'DISPLAY CH1,2     INPUT
280 PRINT@ DM;"CUR 0"       'CURSOL            OFF
290 PRINT@ DM;"DTP 0"       'DATA POSITION     0DIV
300 PRINT@ DM;"DMA 1"       'DMA               OFF
310 PRINT@ DM;"OPM 3"       'SWEEP MODE        SINGLE
320 PRINT@ DM;"RUN 1"       'RUN/STOP          RUN
330 PRINT@ DM;"RST"         'SINGLE RESET
340 '******************* WAIT FOR SRQ= 72 (WAVE IN) *******
350 '
360 IF S<> 72 THEN GOTO 360
370 PRINT@ DM;"RUN 0"
380 '********** CH1 WAVE DATA RCV **********
390 '
400 PRINT@ DM;"JX M10,3,1,0"
410 WBYTE &H3F,64+DM,32+(IEEE(1) MOD 32):      ' UNL,MTA,MLA
420 FOR I=0 TO 1023
430   RBYTE ;BUFFER1(I),LO
440 NEXT I
```

Comments

Line number	Contents
10 to 110	Initial setting
120 to 330	DS-6411 setting
340 to 370	SRQ is transmitted to the controller on completion of Data writing. Receiving SRQ, the controller performs the serial polling, and when the number is found to be 72 (finishing taking in waveforms), it stops taking in waveforms.
380 to 440	Transferred in binary system to the array on which the data, 1 kword, entered into CH1 has been declared.

```
450 '*********** CH2 WAVE DATA RCV ************
460 '
470 PRINT@ DM;"JX M11,3,1,0"
480 WBYTE &H3F,64+DM,32+(IEEE(1) MOD 32);     'UNL,MTA,MLA=30
490 FOR I=0 TO 1023
500   RBYTE ;BUFFER2(I),L0
510 NEXT I
520 '
530 '********** DISPLAY CH1 & CH2 WAVE DATA ************
540 CLS 3
550 SCREEN 2,0
560 WINDOW (  0,-128)-(1024,128)
570 VIEW (50,10)-(400,200)
580 '
590 FOR I= 0 TO 1023
600   YY=BUFFER1(I)
610   IF YY>127 THEN  YY=YY-256
620   PSET (I,-YY)
630 NEXT I
640 FOR I=0 TO 1023
650   YY=BUFFER2(I)
660   IF YY>127 THEN YY=YY-256
670   PSET (I,-YY)
680 NEXT I
690 END
700 *INTR
710 POLL DM,S
720 PRINT "******* INTERRUPTED S=";S
730 SRQ ON
740 RETURN
```

Comments

Line number	Contents
450 to 510	Transferred in binary system to the array.
530 to 680	Waveforms are displayed based on the data stored in the arrays.

6-4-2 HP-216 (I)

Waveforms taken in by DS-6411 are transferred to the controller and displayed.

```
10   !*** INITIALIZE ***
20     S=0
30   !
40     INTEGER Buffer1(2047) BUFFER
50     INTEGER Buffer2(2047) BUFFER
60     ASSIGN @Buffer1 TO BUFFER Buffer1(*)
70     ASSIGN @Buffer2 TO BUFFER Buffer2(*)
80     ASSIGN @Device TO 730
90     ABORT 7
100    CLEAR 7
110  !
120    ON INTR 7 GOSUB Srq
130    ENABLE INTR 7;2
140  !
150    GCLEAR
160  !
170  !*** SET SETUP ***
180  !
190    OUTPUT @Device USING "K";"RUN 0"
200    OUTPUT @Device USING "K";"MOD 4,0"
210    OUTPUT @Device USING "K";"HDS 1"
220    OUTPUT @Device USING "K";"ATD 14"
230    OUTPUT @Device USING "K";"TAS 1"
240    OUTPUT @Device USING "K";"TAC 2"
250    OUTPUT @Device USING "K";"ATP 0"
260    OUTPUT @Device USING "K";"MES 1,1"
270    OUTPUT @Device USING "K";"DTL 0"
280    OUTPUT @Device USING "K";"IPL 0"
290    OUTPUT @Device USING "K";"TMB 0"
300    OUTPUT @Device USING "K";"DSP 0,0"
310    OUTPUT @Device USING "K";"CUR 0"
320    OUTPUT @Device USING "K";"DTP 0"
330    OUTPUT @Device USING "K";"DMA 1"
340    OUTPUT @Device USING "K";"OPM 3"
350    OUTPUT @Device USING "K";"RUN 1"
360    OUTPUT @Device USING "K";"RST"
370  !
380    IF S<>72 THEN GOTO 380
390    OUTPUT @Device USING "K";"RUN 0"
400  !
410  !*** CH1 WAVE DATA RCV. ***
420  !
430    OUTPUT @Device USING "K";"JX M10,3,1,0"
440  !
450    TRANSFER @Device TO @Buffer1;COUNT 2048
460  !
470  !*** CH2 WAVE DATA RCV. ***
480  !
490    OUTPUT @Device USING "K";"JX M11,3,1,0"
500  !
510    TRANSFER @Device TO @Buffer2;COUNT 2048
520  !
```

Comments

Line number	Contents
10 to 150	Initial setting
170 to 360	DS-6411 setting
380 and 390	SRQ is transmitted to the controller on completion of Data writing. Receiving SRQ, the controller performs the serial polling, and when the number is found to be 72 (finishing taking in waveforms), it stops taking in waveforms.
410 to 450	Transferred in binary system to the array on which the data, 1 kword, entered into CH1 has been declared.
470 to 510	Transferred in binary system to the array.

```
530 ! *** GRAPHICS WAVE DATA ***
540 !
550   GCLEAR
560   GRAPHICS ON
570   WINDOW 0,1023,-128,128
580   VIEWPORT 0,400,0,200
590   MOVE 0,0
700 !
720   FOR I=0 TO 1023
730     PLOT I,Buffer1(I)/256
740   NEXT I
750 !
760   PLOT 0,Buffer2(0)/256,-2
770   FOR I=1 TO 1023
780     PLOT I,Buffer2(I)/256
790   NEXT I
800 !
810   LOCAL 7
820   STOP
830 Srq: !
840   S=SPOLL(@Device)
850   DISP "*** INTERRUPTED S=";S S
860   ENABLE INTR 7;2
870   RETURN
880   END
```

Comments

Line number	Contents
530 to 820	Waveforms are displayed based on the data stored in the arrays.

6-4-3 HP-216 (Ⅱ)

Waveforms taken in by DS-6411 is printed out to the plotter through the controller. DS-6411 and the plotter can be set as follows.

DS-6411 ..... ADDRESS 30 CR LF
Plotter ..... ADDRESS 5

```
10   ! **** INITIALIZE ****
20     S=0
30   !
40     ASSIGN @Dv2 TO 705
50     ASSIGN @Device TO 730
60     ABORT 7
70     CLEAR 7
80   !
90     ON INTR 7 GOSUB Srq
100    ENABLE INTR 7;2
110  !
120  ! **** PLOTTER OUTPUT  SETUP ****
130  !
140  OUTPUT @Device USING "K";"RUN 0"    ! STOP
150  OUTPUT @Device USING "K";"MES 1,1"  ! NORMAL
160  OUTPUT @Device USING "K";"MOD 1,0"  ! CH1
170  OUTPUT @Device USING "K";"HDS 1"    ! A
180  OUTPUT @Device USING "K";"ATD 14"   ! 20USEC/DIV
190  OUTPUT @Device USING "K";"OTP 2"    ! OUTPUT PLOT
200  OUTPUT @Device USING "K";"RUN 1"    ! RUN
210  !
220  ! **** OUTPUT START ****
230  !
240  WAIT 1
250  SEND 7;CMD UNL UNT TALK 30 LISTEN 5
260  SEND 7;DATA
270  IF S=68 THEN GOTO 290
280  GOTO 270
290  !
300  LOCAL 7
310  STOP
320  !
330  !
340  Srq:!
350  S=SPOLL(@Device)
360  DISP "*** INTERRUPTED S=";S
370  RETURN
380  END
```

Comments

Line number	Contents
10 to 100	Initial setting
120 to 200	DS-6411 setting
220 to 310	Designate DS-6411 as a talker and the plotter as a listener. After printing out, the plotter receives SRQ, performs the serial polling. When the number is found to be 68 (finishing printing out). It is localized and ends the polling.

MEMO

Appendix

1. SET UP Information . . . . . Appendix 2

2. Collateral Information on the Waveform (Measuring condition at the waveform display) . . . . . Appendix 8

TABLE 1. SET UP INFORMATION

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
1	1	REAL/STORAGE	0 : REAL 1 : STORAGE
2	1	MEASUREMENT MODE	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL
3	1	COUNT	1 : 2 TIMES 2 : 4 TIMES 3 : 8 TIMES 4 : 16 TIMES 5 : 32 TIMES 6 : 64 TIMES 7 : 128 TIMES 8 : 256 TIMES FF_H : ∞
4	1	REPEAT	0 : OFF 1 : ON (0 SEC) 2 : ON (1 SEC) 3 : ON (2 SEC)
5	1	DATA LENGTH	0 : 1 k word 1 : 16 k words
6	1	TIME BASE	0 : INT 1 : EXT
7	1	NOT USED	
8	1	INTERPOLATION	0 : OFF 1 : LINEAR 2 : SINE
9	1	NOT USED	
10	1	NOT USED	

TABLE 1. SET UP INFORMATION (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
11	1	OUTPUT	0 : OFF 1 : PEN 2 : PLOT
12	1	OUTPUT TYPE (PEN)	0 : CAL 1 : SCALE 2 : WAVEFORM 3 : SCALE + WAVEFORM
13	1	ΔVOLTAGE	0 : OFF 1 : ON
14	1	ΔTIME	0 : OFF 1 : ON
15	1	VOLTAGE RATIO	0 : OFF 1 : ON
16	1	PHASE	0 : OFF 1 : ON
17	1	NOT USED	
18	1	PEAK TO PEAK	0 : OFF 1 : ON
19	1	NOT USED	
20	1	GO/NO GO	0 : OFF 1 : ON
21	1	DELAY TIME	0 : OFF 1 : ON
22	1	DATA POSITION	0 : OFF 1 : ON
23	1	DISP SCROLL	0 : OFF 1 : ON

TABLE 1. SET UP INFORMATION (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
24	2	V CURSOR I	0 to 4095
25	2	V CURSOR II	0 to 4095
26	2	H CURSOR I	−2048 to 2047
27	2	H CURSOR II	−2048 to 2047
28	2	REF. V CURSOR I	0 to 4095
29	2	REF. V CURSOR II	0 to 4095
30	2	REF. H CURSOR I	−2048 to 2047
31	2	REF. H CURSOR II	−2048 to 2047
32	1	REF. WAVEFORM VALUE	0 to 255
33	1	NOT USED	
34	1	NOT USED	
35	2	DELAY TIME	0 to 4095
36	1	DISP SCROLL	0 to 10
37	2	DISP ADDRESS	0 to 16383
38	1	V-MODE	1 : CH1 2 : CH2 3 : ADD 4 : DUAL 5 : TRI 6 : X-Y
39	1	ALT/CHOP (REF ON/OFF)	0 : ALT (REF OFF) 1 : CHOP (REF ON)
40	1	TRIGGER SOURCE	1 : CH1 2 : CH2 3 : CH3 4 : LINE

TABLE 1. SET UP INFORMATION (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
41	1	TRIGGER COUPLING	1 : AC 2 : DC 3 : HF REJ 4 : TV
42	1	TRIGGER SLOPE	0 : + 1 : –
43	1	SWEEP MODE	1 : AUTO 2 : NORM 3 : SINGLE
44	1	HORIZ DISPLAY	1 : A 2 : A INTEN 3 : B DLY'D 4 : ALT
45	1	RUNS AFTER/TRIG'D	0 : RUNS AFTER 1 : TRIG'D
46	1	A SEC/DIV	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div

TABLE 1. SET UP INFORMATION (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
47	1	B SEC/DIV	4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div
48	1	NOT USED	
49	1	NOT USED	
50	1	NOT USED	
51	1	NOT USED	
52	1	NOT USED	
53	1	PROBE CH1	0 : 10X PROBE UNATTACHED 1 : 10X PROBE ATTACHED
54	1	PROBE CH2	0 : 10X PROBE UNATTACHED 1 : 10X PROBE ATTACHED
55	1	VARIABLE CH1	0 : CAL 1 : UNCAL

TABLE 1. SET UP INFORMATION (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
56	1	VARIABLE CH2	0 : CAL 1 : UNCAL
57	1	CH2 POLARITY	0 : OFF 1 : ON
58	1	X5 MAG CH1	0 : OFF 1 : ON
59	1	X5 MAG CH2	0 : CAL 1 : UNCAL
60	1	VOLTS/DIV CH1	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
61	1	VOLTS/DIV CH2	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
62	1	X10 MAG	0 : OFF 1 : ON
63	1	A VARIABLE	0 : CAL 1 : UNCAL

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFORM (measuring condition at the waveform display)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
1	1	DISPLAY WAVEFORM MEASUREMENT MODE (FOR CH1)	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL
2	1	DISPLAY WAVEFORM COUNT VALUE (FOR CH1)	1 : 2 TIMES 2 : 4 TIMES 3 : 8 TIMES 4 : 16 TIMES 5 : 32 TIMES 6 : 64 TIMES 7 : 128 TIMES 8 : 256 TIMES FF_H : ∞
3	2	NO. OF CAPTURE OF DISPLAY WAVEFORM (FOR CH1)	0 to 999
4	1	DISPLAY WAVEFORM TIME BASE (FOR CH1)	0 : INT 1 : EXT
5	1	NOT USED	
6	1	NOT USED	
7	1	DISPLAY WAVEFORM INTERPOLATION (FOR CH1)	0 : OFF 1 : LINEAR 2 : SINE
8	2	DISPLAY WAVEFORM DELAY TIME (FOR CH1)	0 to 4095
9	1	DISPLAY WAVEFORM DATA POSITION (FOR CH1)	0 to 10
10	1	DISPLAY WAVEFORM HORIZ DISP (FOR CH1)	1 : A 2 : A INTEN 3 : B DLY'D 4 : ALT

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFORM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
11	1	SWEEP TIME FOR THE WAVEFORM ON DISPLAY (FOR CH1)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div
12	1	SWEEP TIME AT CAPTURING (FOR CH1)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
13	1	DISPLAY WAVEFORM VOLTS/DIV (FOR CH1)	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
14	1	DISPLAY WAVEFORM VARIABLE (FOR CH1)	0 : CAL 1 : UNCAL
15	1	DISPLAY WAVEFORM PROBE STATUS (FOR CH1)	0 : 10 : 1 PROBE UNATTACHED 1 : 10 : 1 PROBE ATTACHED
16	1	DISPLAY WAVEFORM x 5 MAG (FOR CH1)	0 : OFF 1 : ON
17	1	DISPLAY WAVEFORM A VARIABLE (FOR CH1)	0 : CAL 1 : UNCAL
18	2	DISPLAY START ADDRESS (FOR CH1)	0 to 1023
19	2	DISPLAY END ADDRESS (FOR CH1)	0 to 1023
20	1	DUMMY	0
21	1	DISPLAY WAVEFORM MEASUREMENT MODE (FOR CH2)	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
22	1	DISPLAY WAVEFORM COUNT VALUE (FOR CH2)	1 : 2 TIMES 2 : 4 TIMES 3 : 8 TIMES 4 : 16 TIMES 5 : 32 TIMES 6 : 64 TIMES 7 : 128 TIMES 8 : 256 TIMES FF_H : ∞
23	2	NO. OF CAPTURE OF DISPLAY WAVEFORM (FOR CH2)	0 to 999
24	1	DISPLAY WAVEFORM TIME BASE (FOR CH2)	0 : INT 1 : EXT
25	1	NOT USED	
26	1	NOT USED	
27	1	DISPLAY WAVEFORM INTERPOLATION (FOR CH2)	0 : OFF 1 : LINEAR 2 : SINE
28	2	DISPLAY WAVEFORM DELAY TIME (FOR CH2)	0 to 4095
29	1	DISPLAY WAVEFORM DATA POSITION (FOR CH2)	0 to 10
30	1	DISPLAY WAVEFORM HORIZ DISP (FOR CH2)	1 : A 2 : A INTEN 3 : B DLY'D 4 : ALT

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
31	1	SWEEP TIME FOR THE WAVEFORM ON DISPLAY (FOR CH2)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div
32	1	SWEEP TIME AT CAPTURING (FOR CH2)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
33	1	DISPLAY WAVEFORM VARIABLE (FOR CH2)	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 V/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
34	1	DISPLAY WAVEFORM VARIABLE (FOR CH2)	0 : CAL 1 : UNCAL
35	1	DISPLAY WAVEFORM PROBE STATUS (FOR CH2)	0 : 10X PROBE UNATTACHED 1 : 10X PROBE ATTACHED
36	1	DISPLAY WAVEFORM x 5 MAG (FOR CH2)	0 : OFF 1 : ON
37	1	DISPLAY WAVEFORM A VARIABLE (FOR CH2)	0 : CAL 1 : UNCAL
38	2	DISPLAY START ADDRESS (FOR CH2)	0 to 1023
39	2	DISPLAY END ADDRESS (FOR CH2)	0 to 1023
40	1	DISPLAY WAVEFORM CH2 POLARITY (FOR CH2)	0 : OFF 1 : ON
41	1	DISPLAY WAVEFORM MEASUREMENT MODE (FOR REF1)	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
42	1	DISPLAY WAVEFORM COUNT VALUE (FOR REF1)	1 : 2 TIMES 2 : 4 TIMES 3 : 8 TIMES 4 : 16 TIMES 5 : 32 TIMES 6 : 64 TIMES 7 : 128 TIMES 8 : 256 TIMES FF_H : ∞
43	2	NO. OF CAPTURE OF DISPLAY WAVEFORM (FOR REF1)	0 to 999
44	1	DISPLAY WAVEFORM TIME BASE (FOR REF1)	0 : INT 1 : EXT
45	1	DISPLAY WAVEFORM EQU-SAMPLE (FOR REF1)	0 : OFF 1 : ON
46	1	NOT USED	
47	1	NOT USED	
48	1	DISPLAY WAVEFORM DELAY TIME (FOR REF1)	0 to 4095
49	1	DISPLAY WAVEFORM DATA POSITION (FOR REF1)	0 to 10
50	1	DISPLAY WAVEFORM HORIZ DISP (FOR REF1)	1 : A 2 : A INTEN 3 : B DLY'D 4 : ALT

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
51	1	SWEEP TIME FOR THE WAVEFORM ON DISPLAY (FOR REF1)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div
52	1	SWEEP TIME AT CAPTURING (FOR REF1)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
53	1	DISPLAY WAVEFORM VOLTS/DIV (FOR REF1)	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
54	1	DISPLAY WAVEFORM VARIABLE (FOR REF1)	0 : CAL 1 : UNCAL
55	1	DISPLAY WAVEFORM PROBE STATUS (FOR REF1)	0 : 10X PROBE UNATTACHED 1 : 10X PROBE ATTACHED
56	1	DISPLAY WAVEFORM x 5 MAG (FOR REF1)	0 : OFF 1 : ON
57	1	DISPLAY WAVEFORM A VARIABLE (FOR REF1)	0 : CAL 1 : UNCAL
58	2	DISPLAY START ADDRESS (FOR REF1)	0 to 1023
59	2	DISPLAY END ADDRESS (FOR REF1)	0 to 1023
60	1	DUMMY	0
61	1	DISPLAY WAVEFORM MEASUREMENT MODE (FOR REF2)	1 : STORAGE NORMAL 2 : AVERAGE 3 : PEAK CH HOLD 4 : ROLL

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
62	1	DISPLAY WAVEFORM COUNT VALUE (FOR REF2)	1 : 2 TIMES 2 : 4 TIMES 3 : 8 TIMES 4 : 16 TIMES 5 : 32 TIMES 6 : 64 TIMES 7 : 128 TIMES 8 : 256 TIMES FF_H : ∞
63	2	NO. OF CAPTURE OF DISPLAY WAVEFORM (FOR REF2)	0 to 999
64	1	DISPLAY WAVEFORM TIME BASE (FOR REF2)	0 : INT 1 : EXT
65	1	DISPLAY WAVEFORM EQU-SAMPLE (FOR REF2)	0 : OFF 1 : ON
66	1	DISPLAY WAVEFORM GND LEVEL (FOR REF2)	0 to 255
67	1	DISPLAY WAVEFORM INTERPOLATION (FOR REF2)	0 : OFF 1 : LINEAR 2 : SINE
68	2	DISPLAY WAVEFORM DELAY TIME (FOR REF2)	0 to 4095
69		DISPLAY WAVEFORM DATA POSITION (FOR REF2)	0 to 10
70	1	DISPLAY WAVEFORM HORIZ DISP (FOR REF2)	1 : A 2 : A INTEN 3 : B DLY'D 4 : ALT

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
71	1	SWEEP TIME FOR THE WAVEFORM ON DISPLAY (FOR REF2)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div
72	1	SWEEP TIME AT CAPTURING (FOR REF2)	1 : 0.5 s/div 2 : 0.2 s/div 3 : 0.1 s/div 4 : 50 ms/div 5 : 20 ms/div 6 : 10 ms/div 7 : 5 ms/div 8 : 2 ms/div 9 : 1 ms/div 10 : 0.5 ms/div 11 : 0.2 ms/div 12 : 0.1 ms/div 13 : 50 μs/div 14 : 20 μs/div 15 : 10 μs/div 16 : 5 μs/div 17 : 2 μs/div 18 : 1 μs/div 19 : 0.5 μs/div 20 : 0.2 μs/div 21 : 0.1 μs/div

TABLE 2. COLLATERAL INFORMATION ON THE WAVEFROM (measuring condition at the waveform display) (Cont.)

ITEM NO.	SIZE (BYTES)	ITEM	PARAMETER
73	1	DISPLAY WAVEFORM VOLTS/DIV (FOR REF2)	1 : 5 mV/div 2 : 10 mV/div 3 : 20 mV/div 4 : 50 mV/div 5 : 0.1 V/div 6 : 0.2 V/div 7 : 0.5 V/div 8 : 1 V/div 9 : 2 V/div 10 : 5 V/div 11 : 10 V/div
74	1	DISPLAY WAVEFORM VARIABLE (FOR REF2)	0 : CAL 1 : UNCAL
75	1	DISPLAY WAVEFORM PROBE STATUS (FOR REF2)	0 : 10X PROBE UNATTACHED 1 : 10X PROBE ATTACHED
76	1	DISPLAY WAVEFORM x 5 MAG (FOR REF2)	0 : OFF 1 : ON
77	1	DISPLAY WAVEFORM A VARIABLE (FOR REF2)	0 : CAL 1 : UNCAL
78	2	DISPLAY START ADDRESS (FOR REF2)	0 to 1023
79	2	DISPLAY END ADDRESS (FOR REF2)	0 to 1023
80	1	DISPLAY WAVEFORM CH2 POLARITY (FOR REF2)	0 : OFF 1 : ON
81	24	REF BUFFER COLLATERAL INFORMATION (FOR REF1)	
82	24	REF BUFFER COLLATERAL INFORMATION (FOR REF2)	

MEMO